PRODUCING SCIENCE THAT GETS USED BY COASTAL COMMUNITIES:

WHAT FUNDERS SHOULD DO TO LINK MORE SCIENCE WITH DECISIONS

By

Kalle Matso

Bachelor of Arts, 1989, The Colorado College

Masters of Science, 2000, University of New Hampshire

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This dissertation has been examined and approved.

Dissertation Director, Mimi Larsen Becker, Associate Professor, Dept. of Natural Resources and the Environment

Charlie French, Extension Associate Professor, Dept. of Natural Resources and the Environment

Stephen Jones, Research Associate Professor, Dept. of Natural Resources and the Environment

Herman Karl, Visiting Research Faculty, Antioch University New England

Nancy Kinner, Professor, Dept. of Civil Engineering

Thomas Safford, Assistant Professor, Dept. of Sociology

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ABSTRACT

PRODUCING SCIENCE THAT GETS USED BY COASTAL COMMUNITIES:

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Many reports have noted that a significant portion of coastal science that is funded to help society address resource management issues does not actually link to decisions. Here, I report on 13 case studies involving new tools and science to help diverse decision makers better protect coastal resources. My qualitative analysis indicates that the programs' efforts to better link science with decisions have had varied results: some encouraging and some less so. In contrast, all 13 project case studies clearly confirm that the funding programs could have done more to link science with decisions. These case studies, combined with this work's culminating study—a focus group involving 10 different funding programs—point to a series of specific recommendations that funders should consider. Most critically: 1) if solving problems is important, funders need to spend more money on better problem formulation, with an emphasis on involving more people outside of academia and the government sector; 2) if funders are interested in linking science to decisions, they need to allocate more resources to linking, which may involve less resources to science. By linking, I mean supporting activities related to problem formulation to enhance the relevancy of the science to intended users as well as communication of findings to enhance the societal awareness of any new knowledge produced. This dissertation concludes with 10 recommendations in all. While some of these recommendations have overlaps with previous studies and reports, some of them are unique—such as an emphasis on changing proposal review processes—and provide a new contribution to the important debate on how public dollars should be spent within science organizations charged with managing natural resources.

CHAPTER 1

INTRODUCTION

Overview

What is the problem?

Society continues to face many natural resource management challenges. In fact, resource managers may be facing more challenges as populations increase, development increases and changes in weather and climate make problem and solution identification more difficult. Coasts and estuaries, the focus of this dissertation, may be more challenged than other areas since over half of the nation's population lives in coastal watersheds (US Commission on Ocean Policy, 2004).

Science has a role to play in how our society addresses these challenges. Different observers have varying assessments of the relative importance of science as a role player in resource management, as compared with other forces such as politics, culture, religion, etc. Nevertheless, most would agree that science has some role to play in determining resource management problems and potential solutions.

In the United States, the federal government invests billions of dollars (Brown 2006) in various types of science, both curiosity-driven as well as use-inspired (Stokes 1997). Yet many scientists as well as both professional and non-professional decision makers in the resource management arena have expressed concern that society is not benefiting as much as it should from federal investments in science (e.g., National Research Council 1995; Pew Oceans Commission 2003; United States Commission on Ocean Policy 2004; Urban Harbors Institute 2004).

These observers sometimes note that those who sponsor the science—funding agencies—should consider alternative models and programmatic instruments in order to increase the extent to which science is linked to decisions (Ruegg and Feller 2003; United States Commission on Ocean Policy 2004; Sarewitz and Pielke 2007.) In fact, one National Research Council report (NRC 2006) asserts that funding agency program managers have a disproportionate ability to impact how much science actually links with decisions.

It is important, early on, to clarify what I mean by "linking science with decisions." For the purposes of this work, I define "science" as a systematic effort to acquire reliable knowledge about the world. This definition is based on Jared Diamond's conception, as related in his book, "Collapse: How Societies Choose to Fail or Succeed" (Diamond 2005). Following the example of NRC (2009), I use the term "decisions" in a general way, referring to a suite of possible activities, from the choices citizens make about their property to the decisions made by professionals in the environmental field to choices made fishermen and volunteer land use planners. I use the term "linking" to suggest that point at which exposure to information or a tool alters one's beliefs about a problem or decision. This is adapted from the Consultative Group on International Agricultural Research CGIAR Science Council's (2006) conception of the "impact pathway" of research. Finally, the phrase "linking science with decisions" should be considered interchangeable with similar phrases in the literature, such as "linking knowledge with action" (e.g., NRC 2006; Packard 2010).

Justification for Study In coastal and estuarine areas, the value—both monetary and non-monetary—of natural ecosystems has been well studied. Healthy aquatic ecosystems are important recreationally and culturally as well as economically since activities such as fishing and tourism are dependent on strong ecosystems. The US Commission on Ocean Policy, in 2004, estimated that ocean and coastal related activities contributed more than $1 trillion, or one-tenth of the nation's annual gross domestic product, to our national economy. Healthy upland systems (salt marshes, forests) promote necessary watershed processes such as filtering pollution, modulating storm-driven flooding from the land side as well as storm surge related flooding from the ocean side. It is difficult to argue the point that it is critical to ensure that our coastal areas continue to be thriving ecosystems.

It is safe to say that the United States federal government spends billions of dollars on science for the purpose of better managing aquatic resources. Table 1 (below) indicates that at least $2.63 billion was put into the FY 2008 budget for research and development for four agencies alone.

Table 1: Research and development expenditures at a sampling of federal environmental agencies.*

NOAA (R&D)	EPA (R&D)	USGS (Biological Research)	NASA (Earth Sciences Research)	Total
576	540	18	1500	2634

Numbers in millions. Based on FY 2008 budget estimations. Does not capture all research. Also, note that these agencies also have monies specifically allocated to communications and interdisciplinary activities. Purpose is to give a general idea of the scale of expenditures in environmental R&D. (Source = author's investigation of several different federal documents available via agency websites.)

What Kind of Science Am I Interested In? Brown (2006) estimated that in the year 2004, 127 billion dollars was spent on publicly funded science. This dissertation is concerned with how well that money is being spent, specifically with regard to one type of science, which we can refer to as either sustainable or transdisciplinary environmental science. First, let us start more generally with a broad typology of science.

A typology of federal science programs would most likely find that programs are arrayed on a spectrum with "problem-oriented" at one pole and "curiosity-driven" at the other pole. I prefer this conception to the traditional conception of "basic" versus "applied." (For more on the limitations of the basic versus applied conception, see Stokes 1997). Problem-oriented science aims to reduce knowledge gaps with the purpose of building the capacity of specific actors—some of whom should be outside the science world—to pursue certain actions aimed at resource management. "Curiosity driven" research, on the other hand, is conducted with the primary goal of advancing our understanding of the world; applications deriving from that work are welcome but not considered paramount (Stokes 1997).

Under the heading of "problem-oriented" science, one can find many distinct as well as overlapping terms to describe science efforts. Usually, these different categories are arrayed along the spectrum depending on how much the credibility of the science is emphasized—that is, the extent to which the methods meet expectations for technical adequacy (Cash et al 2003)—versus the relevance and legitimacy of the research. Here, relevance means that the research is appropriate to the needs and concerns of users; legitimacy means that the process for generating the research meets expectations for procedural fairness (Cash et al 2003).

The two funding programs studied in this dissertation were both created with a mandate to help decision makers deal with urgent problems facing coastal communities. It was explicit from the beginning that these programs were supposed to have an impact on people outside the sectors of academia and the government, and the impacts from this program's investments were expected to be manifested (at least partially) either during the project itself or shortly thereafter, (i.e., within several years). Two existing types of science—explicitly called out in previous works—correspond to this emphasis on addressing urgent problems in a timely way and involving users outside the research sector: “sustainability science” (e.g., Clark 2007) and “transdisciplinary science” (e.g., Zierhofer and Burger 2007). “Transdisciplinary science,” in my view, is a better term because it focuses attention on the resources required to address problems in truly complex situations, where both the ecosystem processes and the decision making context can be extremely convoluted. Teams addressing this kind of complexity have to not only be interdisciplinary—involving several academic or practical disciplines—but also transdisciplinary, denoting a commitment to involving intended users (or stakeholders) in a collaborative context. Working productively with people from multiple and diverse backgrounds is extremely challenging; a commitment to accomplishing this collaborative work as professionally as possible is the most important characteristic of the kind of science studied in this dissertation.

The assumption of this work is that many kinds of science are valuable from a societal standpoint; it is not the purpose of this dissertation to compare one mode of science to another. However, a second assumption of this work is that, within the broad classification of problem-oriented research, some programs will have more success at reaching the stated goal of linking science to decisions. From a federal policy standpoint, if money is spent for the explicit purpose of solving societal problems in a timely manner, and yet intended audiences are not reaping expected benefits from said research, then this is a problem that warrants attention.

Therefore, the goal of this research is to explore what a funding agency can and should do to better implement transdisciplinary/sustainable environmental science in way that effectively links new knowledge to decisions.

Historical Context

In this section, I will summarize existing literature pertaining to the topic of linking environmental science to decisions, point out gaps, and indicate where my research may contribute to the discussion. I believe this issue relates to two debates, reflected in the literature: 1) what is the role of the scientist in making policy—in our case, in the coastal natural resource management sector, and 2) what can program managers do to influence research impact?

What is the role of the scientist in making policy? This debate reaches back at least as far as the ancient Greeks. Flyvbjerg (2001) details how Aristotle broke with his teacher, Plato, by arguing that studies involving human activity—as transdisciplinary science must—should use human values as a starting point. In other words, context is important and must be part of the equation. For Plato, in contrast, science and true knowledge could only exist through mathematics, which he saw as context-independent. The implication was that involving and admitting human subjectivity was mutually exclusive with the conduct of science. Note how Aristotle's conception is much more consistent with the Ecosystem Based Management's charge to integrate ecological and social sciences (Compass 2005). This debate is very relevant to the question of the role of the scientist, because if you believe that true science is separated from human subjectivity, there is a strong incentive against working with users in a collaborative fashion.

This debate emerged again most notably after the Renaissance, in the 17th century, and continues to this day. The gist of the debate, especially as it relates to the conduct of science, can be boiled down to two disparate positions, which I will refer to as context-dependent and context-independent. (I use my own terms since the plethora of terms I've encountered are often confusing and counter-intuitive.) In the context-independent school, truth and knowledge can only be attained through logic, mathematics and facts that are objective and verifiable by the senses. Those in the context-dependent paradigm, on the other hand, believe that few discoveries of real import are completely objective or reducible; rather, the best science will acknowledge human subjectivity and attempt to effectively account for it (Flyvbjerg 2001). In the context of policy sciences, Clark's (2002) description of this dichotomy is instructive.

> According to the traditional view, science is understood to be value-free, objective, and reductionistic in its search for universal laws, its use of formal rigor, and its application of quantitative precision. This kind of science is, without a doubt, good at solving certain kinds of problems, especially those that can be controlled, and its success is largely the result of the great care scientists take in selecting problems. But toxic wastes, ecosystem degradation, and species endangerment, for instance, are not problems selected by scientists and investigated under carefully controlled conditions. [In these cases], the philosophy and methods of experimental science are not sufficient—even though they may be necessary—for their resolution." (Clark 2002, Chapter 3).

Donald Stokes' important and highly regarded work, "Pasteur's Quadrant" (1997) details how this longstanding debate impacted science and technology policy in the United States, primarily through the influence of Vannevar Bush, director of the Office of Scientific Research and Development under President Franklin D. Roosevelt. Bush published a report entitled "Science, the endless Frontier," (Bush 1945) which Stokes credits with setting the trajectory of science and technology policy to this day. Bush was an engineer trained in the context-independent scientific tradition and his particular perspective imbued his report and generations of scientists and policy makers that came after him.

In this report, Bush emphasized the importance of basic research versus applied research. He also emphasized the linear conception of knowledge flow: that is, knowledge begins with researchers developing an idea, passing it off to applied researchers, who in turn deliver it to waiting users. He also warned that, when mixed, applied research would drive out basic research. While none of his claims were wrong per se, the enduring effect of his report was a distrust of use-inspired science and an almost blind belief in a one-to-one correlation between societal benefit and investment in basic research (Stokes 1997).

Stokes then presents an alternative viewpoint to that of Bush. In the Stokes paradigm, basic and applied research can and should mix, as they do in what he calls Pasteur's Quadrant. He dedicated the quadrant to Pasteur as that scientist began much of his work on fundamental processes because of very applied questions, such as helping a beverage manufacturer understand why his wines were being contaminated. While Stokes' views have had great influence on academics in the science and technology sphere (see Ruegg and Feller 2003), it is unclear to what extent his book has impacted coastal research program managers and directors. Brunner et al (2005) note that remnants of the context-independent school are still very much engrained in United States law, policy, and other aspects of natural resource management.

Simultaneous to these developments in the science and technology policy sphere, much has been published and continues to be published regarding the democratization of science, both in order to achieve more robust environmental progress as well as to fulfill social justice obligations (e.g., Mog 2004; Norgaard and Baer 2005; Sarewitz and Pielke 2007). Since these papers also delve into exactly what program managers and others can do to influence research design and/or research incorporation into natural resource management, I will discuss this literature in more detail below.

What can program managers due to influence the extent to which research is incorporated into resource management? Regardless of the sector of concern (e.g., environment, health, defense), certain observations with regard to the diffusion of knowledge are relevant to the question of the role of the funding program manager. One point that turns up quite often is that public policy operators often make the mistake of putting much more energy into the creation of new knowledge than they into the dissemination of that knowledge (Tornatzky and Fleischer 1990; Rogers 2002;

Stoneman 2002; Feller and Ruegg 2003). In other words, some diffusion does occur passively, but there is no doubt that the rate of diffusion can be augmented by public policies, such as through setting of regulatory standards, acting as a communications bridge between users and developers or through encouraging cooperative user groups to increase market power (Tornatzky and Fleischer 1990; Stoneman 2002). In Yin and Moore's (1988) insightful case study involving the natural hazards field, a similar conclusion was reached.

> What was discovered in these case studies was the persistent role of such [professional communications] interactions…Furthermore, the project design and conduct was influenced by information from users. Where, in contrast, research projects were conducted in a more traditional manner that was removed from the potential users, utilization was impaired. (Page 41)

Specific to the natural resource management sector, Rogers (2002) notes the importance of the agricultural extension model in calling out some essential ingredients for success. First, adequate funding is required. The agricultural extension program was built on the idea that for every dollar of research a dollar of extension would be allocated. Second, information and technology transfer occurs through relationships. Successful stories of adoption of new ideas involve champions and boundary spanners.

The idea of spanning boundaries is especially critical in the context of Ecosystem Based Management. As discussed earlier, by definition, Ecosystem Based Management involves a variety of perspectives, disciplines and institutional structures. In this context, effective communication becomes even more important. It is informative to look to the Great Lakes of the U.S. for lessons in this regard, since it is generally acknowledged that Ecosystem Based Management, as it used in North America, had its origin in the environmental planning in the Great Lakes Basin and the Great Lakes Water Quality Agreement of 1978 (Slocombe 1998). MacDonagh-Dumier et al (2003), in reviewing the reasons for Great Lakes successes, stress the many communications mechanisms, both formal and informal, which allows the development of "collegial relationships" and collaborative research.

Theoretical Framework

As noted above, a very traditional view of the relationship between science and policy holds that scientists should focus on increasing the reservoir of knowledge that is in the public domain. The public then has the ability to access that knowledge when they please and utilize it to make decisions and appropriate policies. Figure 1 depicts this basic conception.

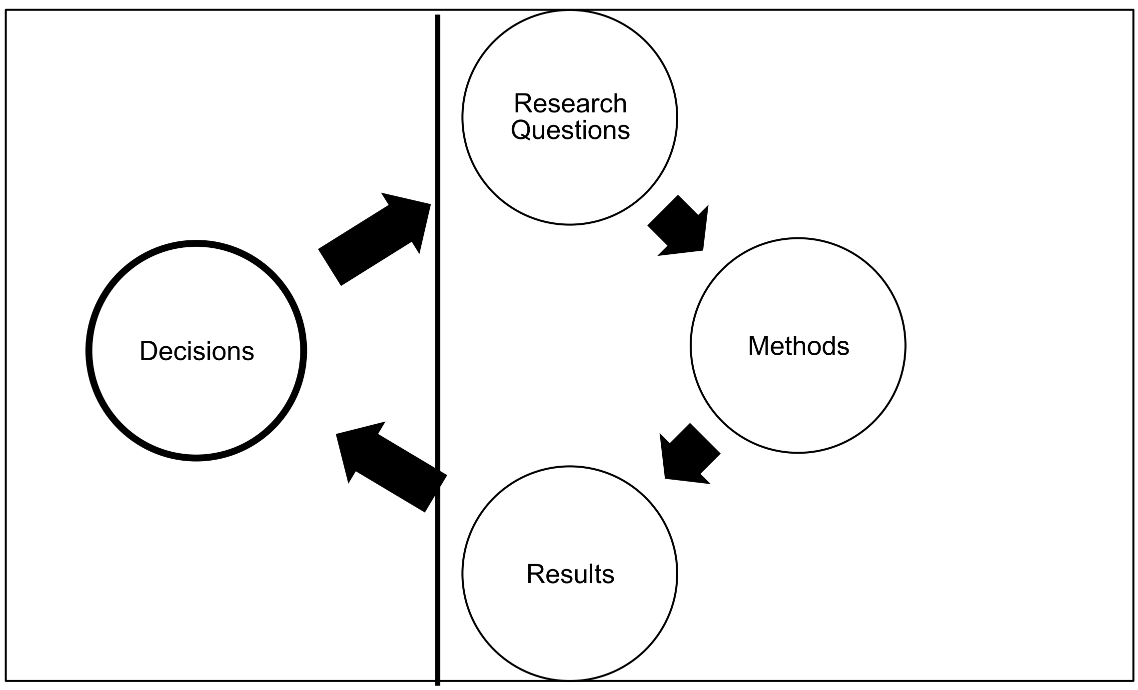

Figure 1. (Adapted from Barreteau et al 2010.) Traditional conception of the relationship between science and decisions. Note that the area left of the vertical divider is where activities such as outreach, stakeholder interaction, and evaluation of research occur, according to this paradigm. The bold outline of the "Decisions" circle indicates that this is the point at which research bears fruit and evaluation should begin, again, according to the traditional paradigm.

In the last decade, previous work from 1990's and earlier came together in a key publication (Cash et al 2003) to proffer an alternative conception of how science links to decisions. Cash et al (2003) draw on substantial empirical research to show that decisions are linked to science most effectively when three attributes of the research and the research process (from the perspective of scientists and stakeholders) are maximized: credibility (meeting technical standards), relevance (appropriate for the users), and legitimacy (procedurally fair).

Referring again to Figure 1, in this view there would be no need for a vertical divider because the process is seen as a critical part of the scientific product. Therefore, stakeholders, communications experts, etc. would need to be a part of all the phases, not just the decision phase. Of course, it would be simplistic to suggest that there is a

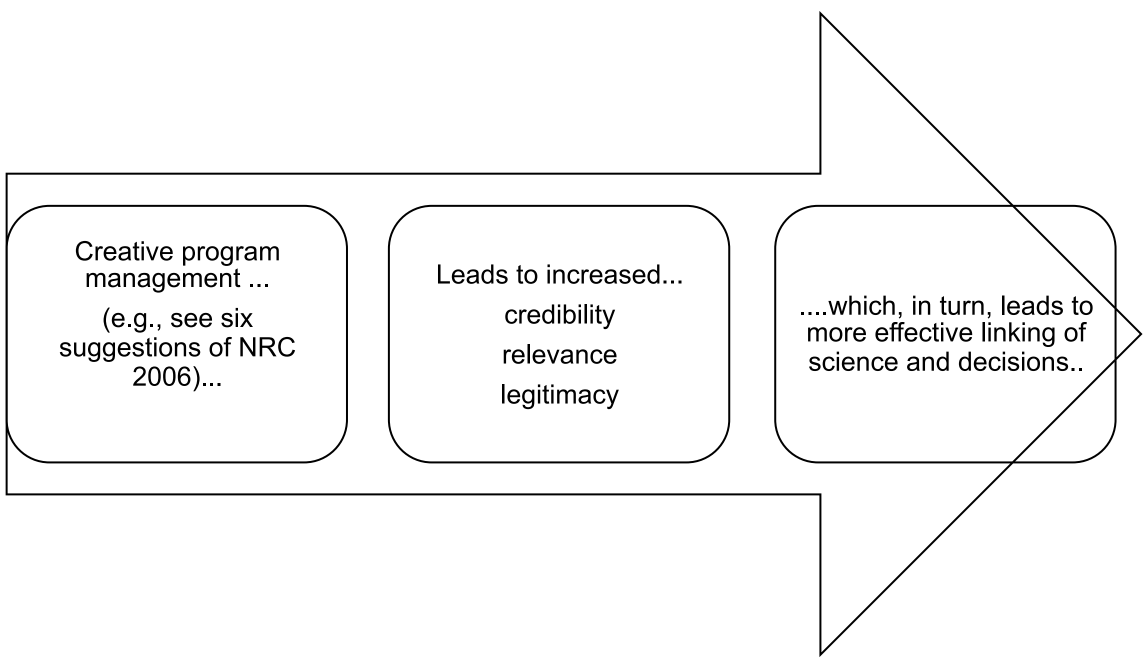

Figure 2. Conceptual model of how to improve links between science and decisions.

clear line between the “traditional” and alternative approaches to applied science. For example, one of the programs studied for this work defines collaborative research generally as involving “an explicit and justified plan for the interaction of applied science investigators and intended users throughout the project. The reader will no doubt realize that many different types of collaborative proposals could satisfy this general description, and these proposals could have significant differences in how they allocate resources to achieve their objectives.

These two theories—the three attributes (credibility, relevance and legitimacy) and the disproportionate influence of the program manager—can be woven together into a simplified conceptual model (Figure 2 above) for the purposes of grounding this research. Over the past 10 years, along with my colleagues, I have endeavored to implement creative program management strategies with the goal of increasing the credibility, relevance and legitimacy of the research we fund. The following chapters represent an effort to understand three things. First, are our projects linking science with decisions? Second, what specific mechanisms are responsible for how much the science is linking to decisions? Third, what can we—and perhaps other funders—do to better link science with decisions?

Dissertation Organization

Since 2003, I have worked on two competitive grants programs, both representing partnerships between NOAA and the University of New Hampshire. The first was the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), which began in 1997 and will end in 2012, having funded its last cohort of projects in 2009. The second program is called the NERRS Science Collaborative, heretofore referred to as "the Collaborative." (NERRS stands for the National Estuarine Research Reserve System). The Collaborative received a 5-year grant from NOAA for the period of 2009 to 2014.

The core of the research involves three Requests for Proposals (RFPs), starting in years 2007, 2009, and 2010: the first two sponsored by CICEET and the last by the

Collaborative (see Table 2 below). Each RFP is different, involving different program management strategies, review processes, RFP demands, reflecting the program

Table 2. Attributes of the three RFPs studied for this research. The bottom row also shows the data collected and analyzed as it pertains to each cohort.

	Cohort 1 **Land Use - 2007**	**Cohort 2** **Land Use/Climate 2009**	**Cohort 3** **Collaborative 2010**
Start Date, Duration	9/2007 Up to 2 Years	9/2009 Up to 2 Years	9/2010 Up to 3 Years
Average Annual Budget	111,665 n = 3*	119,061 n = 4	233,206 n = 6
RFP Focus	- Very focused - Determined by surveys & interviews	- Fairly General - Determined by needs of intended users	- Very General - Determined by needs of intended users
Noteworthy RFP Require-ments	- Include training, outreach - Partner with a community	Include "leads" for technical; collaboration; evaluation; dissemination	- Detailed methods for "applied science" as well as collaboration - Collaboration Lead
RFP Related Outreach	n/a	n/a	- Webinar - Networking at NERRS Conf. - Collab Research Primer w/RFP
Review Process Highlights	- No write-in reviews - Panelists mostly strong in biophysical science,planning	- Write-in reviews - Panelists mostly strong in applied biophysical science	- Write-in reviews - Panelists mostly strong in applied biophysical science - Weighting criteria show applied science and collaboration are of equal import
PhD Analysis	- Interviews re: linking science & decisions	- Interviews re: linking science & decisions - Direct Observation of collaborative meetings	- Direct Observation of collaborative meetings - Interviews re: collaborative meeting

manager team's decision to make changes to improve the process after each competition. Simply put, when a competition concluded, the team looked at what they'd hoped to achieve, looked at the proposals they'd received as well as other feedback on the process and made changes it felt would lead to better linking of science to decisions. A general description of these three RFPs can be found in Table 2 above. The complete text of all RFPs mentioned in this dissertation can be found in the Appendices.

The next chapter (Chapter 2) will present case study information on three projects from Cohort 1, which began in 2007 (see Table 3 below). Results are presented for each of the three case studies and attention is also paid to those results held in common by all three projects. The same approach is taken in Chapter 3 dealing with the four projects funded under the 2009 RFP. This chapter also includes some information related to direct observation data, since it was possible to visit these projects before they were completed. (Readers will note that the far right column indicates whether the chapter is formatted as a peer-reviewed paper submission. This explains certain attributes of the chapters—for example, the fact that certain methods are described in multiple places—that otherwise may have caused confusion.)

Examining the Collaborative projects that started in 2010, Chapter 4 puts the spotlight specifically on what could be an important issue regarding better linking science to decisions: how to structure effective interactions between researchers and intended users. As noted in the “Historical Context” section, there is a broad consensus that these interactions need to happen more. Yet, with the exception of a few journals—most notably, “Ecology and Society, “Policy Science,” and “International Journal for Public Participation—there has been little emphasis paid to the specifics of how these interactions should be operationalized or even if the details are actually that important. In other words, is it enough to simply get these disparate people in the same room? Since the preliminary data collected for Chapters 2 and 3 indicated that, indeed, these interactions were not as simple to implement as project team members had anticipated, I determined that using one chapter to focus on these interactions—or participatory processes—would be of benefit to the goal of understanding what funders can do to better link science to decisions.

Table 3. Dissertation chapter organization. The column to the far right notes whether the chapter is written as a peer-reviewed journal submission.

Chapter	**Data Sources**	**Format as Paper (Y/N)**
1 – Introduction	n/a	No
2 – 2007 CICEET RFP - Land Use Planning Tools - 3 Projects	For each project, interviews with: • 2 project investigators • 2 project users	Yes
3 – 2009 CICEET RFP - Land Use & Climate Change - 4 Projects	For each project, interviews with: • 2 project investigators • 2 project users Direct observation of meetings in last quarter of the project.	Yes
4 - 2010 Collaborative RFP - Coastal Resource Management - 6 projects	Direct observation of initial meetings with follow-up interviews regarding the quality of the interactions. Interviews with: • 2 project investigators • 4 project users	Yes
5 – Innovative Funders Focus Group	Survey and recorded discussion with 13 funding program managers, representing 10 different funding programs.	Yes
6 – Review of the Most Salient Findings, Recommendations, and Plans for the Future	Previous Chapters. Additional data regarding changes made to RFP and review process after 2010.	No

Reflecting on chapters two through 4, a valid critique could point out that CICEET and the Collaborative were run by the same group of people and represent only one way of approaching these issues. What about other innovative programs such as NOAA Sea Grant, NOAA's Climate Program or programs funded by the National Science Foundation? In order to incorporate lessons learned from these other programs, this dissertation includes a focus group research effort, the subject of Chapter 5 (see Table 3 above). The goal of the focus group is to take a group of people who agree on the need for new ways to link science to decisions, and then see where we converge and diverge in terms of specific practices.

Finally, in Chapter 6, I will endeavor to synthesize critical findings from the previous chapters into some key recommendations for funders interested in better linking science with decisions. This chapter will also include some preliminary data relating to the most recent cohort of projects funded by the Collaborative, which began in 2011. Based on very early-stage feedback from applicants, program staff and panelists, this last competition may provide a unique model for fostering collaborative research within a competitive grants context.

Research Approach

The data analyzed for this dissertation comes from in-depth interviews with both project team members as well as representatives of the intended user audience for projects within each of these three cohorts. For the first two cohorts, the interviews focused on prospects for linking science to decisions, the user involvement experience, and questions regarding the key factors influencing the extent to which the science might link to decisions. Since the last cohort of projects began in earnest only just more than a year from when this is being written (spring, 2012), these interviews focused instead on initial meetings between project team members and intended users (see Table 2). Follow-up interviews will take place in 2013 and subsequent years, but will not be included as part of this dissertation.

Note also that I was able to directly observe late-stage investigator-user interactions for the projects beginning in 2009 as well as early-stage investigator-user interactions for projects beginning in 2010. Richards and Morse (2007) note that direct observation provides opportunities to collect data not obtainable by simply asking participants questions. For example, in some cases, participants may not be aware of their own behaviors or attitudes.

Analytical Approach For this dissertation, the primary mode of analysis is qualitative, not quantitative. Let me clarify how I am using these terms. I define a quantitative approach as focusing on the rejection or acceptance of some stated hypothesis based on random assignment of treatments—the "true experiment"—or non-random assignment of treatments—the "pseudo-experiment" (Creswell 2003). With quantitative analysis, there is usually an ex ante attempt to establish a relationship between dependent and independent variables. Further, statistics are usually used to reduce the inquiry to a numerical relationship between a set of observed measurements (Creswell 2003).

Qualitative methods, on the other hand, normally emphasize a mode of inquiry that does not pre-suppose specific relationships between sets of variables associated with the phenomenon of interest. Strauss and Corbin (1990) do, however, note that grounded theory—one kind of qualitative research—can be used to test theory rather than to create theory. Yet even in this instance, the approach is supposed to be open, flexible and iterative. That is, relationships and patterns are noted and then the researcher returns again to the data—or collects more data—to strengthen the emerging explanation of why a certain phenomenon has occurred in a certain way.

It is important to clarify that this is not a quantitative "treatment" based analysis seeking to compare the effectiveness of the three different RFPs being studied. Such an approach requires a level of control over the variables that simply does not exist in this situation. The experiment approach is especially confounded by the fact that the projects within these cohorts began at different times and so are at different stages of maturity.

Rather, this research takes a cross-case analysis approach. For each case study, I have tried to describe what has happened and why. Looking across all 13 case studies, then, I will look for those mechanisms and perspectives that seem to be the most prevalent. The purpose is not to state that a mechanism or perspective is statistically significant; rather, the logic is that factors that occur in the most number of case studies are most worthy of attention from funding agency program managers seeking to better connect science with decision making.

It is important to discuss briefly why a case study approach is appropriate to my goals. Case studies are appropriate for situations when the inquiry involves “how” or “why” questions, is deeply embedded in a real-life context and when the phenomenon of interest has multiple variables, many of which are unknown to the researcher at the outset of the work (Yin 2003). Proponents of case study research assert that a single case study, when done rigorously, has the potential to provide reliable and even generalizable knowledge, the same way a “high n” experiment does (Flyvbjerg 2001; Yin 2003).

For example, Flyvbjerg (2001) notes the story of one single experiment, supposedly conducted by Galileo, which effectively disproved Aristotle’s conception of gravity, which had been held as unassailable for nearly two thousand years. This is the famous incident wherein Galileo dropped two objects—one heavy and one light—from the Tower of Pisa and noted that they hit the ground at the same time. The experiment can also be done by using a piece of lead and a feather within a vacuum tube; they fall at the same rate. In some contexts, all it takes is one case to radically change our understanding of our world. Simply put, if a case study shows that X happens, it is impossible now to say that X doesn’t happen. That is powerful.

An additional advantage of the single case study is the ability to delve deeply into phenomena, looking exhaustively for data to confirm or reject emerging patterns and theories. I knew that adding multiple cases, since time is limited, would limit my ability to burrow deeply into the case’s details. Therefore, if a single case study can be sufficient, why do multiple case studies, as I am doing in this dissertation? This is an important question and one I thought a lot about.

In the end, I saw opportunities for additional learning through the multiple case study approach as compared with the single case study. Since many of the projects I studied dealt with different technical, social and political contexts, I felt I might learn something about how different findings might be more or less durable, despite changes in regions, culture and personality types.

In summary, each case presents the possibility to see what factors play key roles in science linking to decisions and what funders could do to increase the linkage. While this analysis seeks to honor what can be learned from each individual case study, it also seeks to extract those lessons learned that seem to emerge from all analyzed cases within a cohort; such findings could be of particular interest to funders with limited resources to make improvements.

<u>Data Collection</u> The data for this research project were collected primarily through semi-structured interviews (Dillman 1978) and direct observation (Richards and Morse 2007). The semi-structured format allows the researcher to ask follow-up questions for clarification or elaboration when it is deemed appropriate. For the semi-structured interviews, questionnaires were sent to interviewees ahead of time and interviews were conducted in all cases over the phone and recorded for later transcription. Interviews were both transcribed, organized and analyzed using NVIVO 9.0, an industry standard qualitative research software package.

Two questionnaires were used for this research. For the more mature CICEET projects, beginning in the years 2007 and 2009, Instrument 1 (see Chapters 2 and 3) was used to understand: general attitudes towards linking of science to decisions; issues related to collaboration between users and investigators; important factors to consider regarding linking science to decisions; and what funders can do to better link science to decisions. These interviews took between 25 and 45 minutes to conduct.

For the Collaborative projects, which began in 2010 and were only a little over a year into their 3-year projects at the time of this writing (spring, 2012), Instrument 2 (see Chapter 4) was used to understand interviewees' perspectives on initial meetings between investigators and users. Was the meeting effective with regard to the goal of linking science to decisions? How could it have been better? In addition to the open-ended questions, interviewees were asked to rate the effectiveness of the meeting using a five-point Likert-type scale. Additionally, interviewees were asked for their views and experience regarding research that emphasized a more collaborative approach. These interviews were conducted within two weeks of the meetings themselves and took between 8 and 15 minutes to complete.

It is important to clarify the types of "users" interviewed for this dissertation. For all projects, applicants were asked to offer in their proposal a description of the "intended user" landscape, based on the problem that they had identified. For example, a project focused on land use planning in coastal communities would typically focus on regional and municipal planners or town engineers as well as active citizens in those communities. In some cases, the "intended users" were biophysical scientists from a state or federal agency. It was also common for users to be staff representing non-profits such as watershed planning organizations, etc.

In all four cases, choosing the two project team investigators to interview was fairly straightforward. Due to the nature of the RFP, it was very clear who on the project had responsibility for the tool or biophysical science development and who had more responsibility attached to actually linking science to decisions. With regard to choosing two people from the target user audience, the initial research proposals were used so that I could suggest some names to the project investigators. In communicating with the project investigators, I often asked, “Of the following users, please name two who you would especially want to actually use and be satisfied with this tool given that you want this tool to have maximum benefit on coastal resources.”

Direct observation by the researcher was used to add additional insight into the qualities of the interactions between users and investigators. As noted earlier, direct observation allows researchers to note factors and occurrences that the participants themselves may not be aware of. Details on direct observation methods are offered in Chapters 3 and 4.

For me, direct observation was especially critical in understanding how to improve interactions between users and investigators. Until recently, I had the commonly held belief that some meetings go well and some meetings go bad, but that the quality of the meeting was not necessarily in the control of any particular person. Rather, it came down to the personalities of the participants and the vicissitudes of the various moods in the room.

Since 2006, however, when CICEET began working consistently with someone with facilitation training, I have seen a significant increase in meeting effectiveness. Because anecdotal evidence leads me to believe that most people are unaware of how effective meetings can be—although they are aware of how excruciating bad meetings can be—it seemed critical to ensure that someone with relatively high meeting standards was able to observe meetings between users and investigators.

<u>Data Analysis</u> Analytical methods used here are most similar to what Yin (2003) refers to as “explanation building.” Explanation building is distinct from other case study methodologies, according to Yin, because the researcher makes an explicit choice at the beginning of the research not to make predictions about what the final explanation will be. Rather, the researcher iteratively considers the results in light of the most applicable theories. When the research is concluded, the researcher may have validated existing

theories or added modifications to existing theories. Additionally, the researcher can pave the way for the development of new theories. In the case of my dissertation, the theoretical context that is most relevant comes from Cash et al (2003): namely, research most effectively links to decisions when it is credible, relevant and legitimate.

This dissertation also draws heavily on the analytical approach known as “grounded theory,” but I do not consider it to be a true grounded theory project, for reasons that I will discuss in a moment. First, how is this approach similar to grounded theory? Like “explanation building,” grounded theory is designed for causal factors to emerge as the data are explored, rather than being explicitly stated before the research begins (Strauss and Corbin 1990; Charmaz 2006).

Second, grounded theory specifies a methodological approach known as “coding.” Coding is the systematic procedure of going through the data—in this case, transcripts—line by line and labeling the words, sentences or paragraphs and then putting them in categories according to their attributes (Strauss and Corbin 1990; Charmaz 2006). The role of coding can perhaps be best understood by examining the idiomatic expression: “that person can’t see the forest for the trees.” This expression usually refers to people who are so obsessed with the details that they can’t see the whole truth. In a way, coding is a way to address people’s tendency to see the forest in the way they want to see it—because of their biases perhaps—which may result in them defending their view of the forest by only pointing out the trees that support their theory. This would obviously pose a problem to the internal validity of the research (see discussion on validity below). Coding forces the researcher to look at every tree, put its attributes in its proper place so that when it’s time to see the forest whole, it is much harder to deceive oneself and thus the process becomes much more likely to produce reliable knowledge. In the chapters to come, I will offer more detailed examples of my approach to coding.

I noted earlier that my methods don't strictly adhere to grounded theory. Grounded theory involves many iterations of coding, first using "open coding" to break data down into parts, then "axial coding" to slowly draw connections between parts and, finally, "selective coding" to more fully depict causal relationships regarding the phenomenon of interest (Strauss and Corbin 1990; Charmaz 2006). Because my research concerns 13 different case studies, I was simply unable to apply this many iterations to the data. Therefore, I essentially used all three levels of coding simultaneously, reading through the transcripts and labeling connections and causal relationships as I did so. To be sure, I did conduct quality assurance procedures to insure the reliability of my analysis. My point rather is that the coding process was not as iterative and compartmentalized as Strauss and Corbin (1990) and Charmaz (2006) depict it.

I should point out that both "explanation building" and "grounded theory" are designed in order to generalize to theory, rather than generalizing to a population (Yin 2003). For scientists used to the hypothesis testing approach (usually involving statistics), this can be a difficult concept to absorb. Most "high n" quantitative studies—including a lot of survey-based work—seek what Yin calls statistical generalization. That is, these studies strive to make accurate statements about a given population, by extrapolating from studies of a sub-sample. In contrast, the methods in this dissertation are designed to provide "analytical generalization," so that the empirical results can be explained or applied to a given theory, whether that theory was pre-existing or emerged for the first time during the course of the research.

<u>Validity and Reliability of Coding Processes</u> Construct validity relates to whether appropriate measures (e.g., questionnaires, surveys, etc.) were used for the inquiry. To increase the construct validity of these methods, interviews were piloted—in some cases, multiple times—in order to refine and improve the questionnaires. Internal and

external validity refer to how I establish causal relationships and how I establish the domain to which results can be extended, respectively (Yin 2003). I sought to improve the internal validity of my research by collecting data from multiple sources and by reviewing my conclusions with those I had interviewed, by sending all interviewees drafts of my dissertation chapters. I sought to improve external validity by clearly describing the context of each case so that readers could better decide if the results were applicable to their respective situations.

Reliability refers to the reproducibility of the analytical procedures. To increase the reliability of these methods, coding approaches were shown to colleagues in order to improve the analytical logic. In addition, a second "coder" analyzed several interviews to verify that this researcher's observations, categories and data organization were comprehensible and appropriate. Also, all codes were reviewed at least once after several days had passed from the initial coding effort. This is made simple through the use of NVIVO software. One simply "double-clicks" every code in the database and the program reveals every segment of transcript that correlates to that code. The researcher can then verify that the initial code makes sense.

There are two reasons why a code may not make sense. First, there could have been an operational mistake, such as making a mistake with the keyboard or mouse, that could result in a piece of data being miscoded. Second, there could have been a mental mistake. The coder could have been tired or getting sloppy at the time of coding, resulting in a code or label that, upon second inspection, is not consistent with the analytical approach. This sort of quality assurance/quality control is similar to rechecking electronic data sheets versus field notes to make sure that data has been transferred accurately.

<u>"Theoretical Sensitivity" and Bias</u> Having served as a funding program manager since 2003, I have a strong understanding and appreciation for the ways that the funding

program manager can exert influence over the scientific process. I have published on this topic and served on various panels such as the Research to Applications Task Force of the Ocean Research Advisory Panel (RATF 2007). This gives me some confidence in claiming to understand methods that can and cannot work with regard to better linking science with decisions. Over the last nine years, along with my colleagues, I have tried many common and perhaps less common approaches to making science more visible and more useable. I have seen some things succeed beyond my expectations, and I have seen many things fail due to consequences we did not foresee.

This "theoretical sensitivity" (Strauss and Corbin 1990) comes into play as I analyze my interviews. If an interviewee notes that "the science was strong but it didn't really address the problem," I can analyze that feedback with the perspective of someone who has actually tried to address that issue and seen the effect. If an investigator notes that "user interactions are really complicated and the conversations can easily get sidetracked," again, I have seen approaches for dealing with that issue. All this gives me a particular ability to add to an investigation of "what funders can do" to link science to decisions. However, this experience also limits me. When one has spent a good amount of time within a system, it is easy to have one's thinking constrained by convention and what has gone before. It is also easy to become overly confident that I and my colleagues have "tried it all," and this limits innovation and the development of creative ideas on why science links to decisions and what funders can do about it. In contrast with other approaches that purport to eliminate bias, qualitative inquiry holds that biases cannot be decreased or eliminated. Making those biases transparent, therefore, is necessary to assess the quality of the science.

<u>Study Limitations</u> Understanding the extent to which science gets used is a notoriously difficult endeavor (Tornatzky and Fleischer 1990; Ruegg and Feller 2003). Research use is a long-term phenomenon on the order of decades and is non-linear as well. Any study

that monitors the phenomenon for less than the decades it would take to track the lifespan of the knowledge is therefore limited and all projections about the use of the research come with significant caveats.

It is important for readers to understand that this research is significantly affected by its focus on the NERR System, because the specific characteristics of the System affect the types of stakeholders who become part of the various projects studied. This, in turn, could impact the findings of the research. For example, compared with the National Estuary Program (NEP), which also as 28 sites around the country, the Reserves are much more focused on conservation and restoration science as well as education, along with estuarine ecology. Therefore, the stakeholders that work with Reserves tend to be conservation groups, planners, etc. In contrast, NEP stakeholders tend to be more dominated by regulators.

Another limitation of the study has to do with the sources of the data: namely, the project participants. Human subjects provide relative rather than absolute data. For example, if a user says the research wasn't used because it wasn't relevant, the researcher must accept that this may or may not, in fact, be true. Research has shown that interviewees asked the same question at two different times can offer two different answers. Therefore, the complexity of the human mind offers a limitation to this study. Again, the best control for this limitation is the collection of evidence from multiple viewpoints and multiple sources of data as well as a focus on explanations that are compatible with multiple perspectives.

I believe the above limitations apply to many studies, whether qualitative or quantitative. I have attempted to thoroughly characterize the strength of my approach as well as its limitations. In qualitative research as well as in quantitative research, this is what a researcher must do and what he/she is limited to, because in the end, it is up to the user to decide what science rings true and will therefore link to decisions.

CHAPTER 2

FUNDING SCIENCE THAT CONNECTS TO DECISIONS:
CASE STUDIES INVOLVING COASTAL LAND USE PLANNING PROJECTS

Introduction

Society continues to face many natural resource management challenges. Identifying problems and solutions is difficult in the face of population growth, increasing development and changes in weather and climate. This is especially true for coasts and estuaries since over half of the nation's population lives in coastal watersheds (US Commission on Ocean Policy, 2004).

Science has a role to play in how our society addresses these challenges. Different observers have varying assessments of the relative importance of science as a role player in resource management, as compared with other forces such as politics, culture, religion, etc. Nevertheless, most would agree that science has some role to play in determining resource management problems and potential solutions.

In the United States, the federal government invests over a hundred billion dollars annually on science (Brown 2006). Within the coastal sphere, many scientists and stakeholders have expressed concern that society is not benefiting as much as it should from federal investments in science (e.g., National Research Council 1995; Pew Oceans Commission 2003; United States Commission on Ocean Policy 2004; Urban Harbors Institute 2004; Donahue 2007). In other words, not enough science is linking with decisions. (For the purposes of this work, I define science as “a systematic effort to acquire reliable knowledge about the world.” This definition is based on Jared Diamond’s conception, as related in his book, “Collapse: How Societies Choose to Fail or Succeed” (2005). I use the term “decisions” in a general way, referring to a suite of possible activities, from the choices citizens make about their property to the choices made by professionals in the environmental field to choices made fishermen and volunteer land use planners and other coastal/estuarine resource users. Finally, I use the term “linking” to suggest that point at which exposure to information or a tool alters one’s beliefs about a problem or decision. This is adapted from the conception of the “impact pathway” of research presented in the CGIAR Science Council’s 2006 report.)

A portion of these observers sometimes note that those who sponsor the science—public, non-profit and and private funding agencies—should consider alternative models and programmatic instruments in order to increase the extent to which knowledge is linked to decision making (Ruegg and Feller 2003; United States Commission on Ocean Policy 2004; Sarewitz and Pielke 2007.) A 2006 report by the National Research Council (NRC) went so far as to specify six critical principles that program managers should adhere to in order to better link science with decisions; the were: define problem with users; define clear project goals and accountability; use boundary spanning organizations; place work in a decision chain and be aware of links on either side; experiment and incentivize innovation in program management; ensure continuity and flexibility of budget.

During this same time, a theory first offered in 2003 by Cash et al became more widespread; the NRC explicitly endorsed the theory in several of its publications (e.g., NRC 2007a; NRC 2009). Based on over a decade of empirical data relating to research programs in the natural resource sector, Cash et al (2003) found that three attributes most determined the extent to which science linked to decisions: credibility, relevance and legitimacy. Credibility refers to whether all stakeholders perceive the information as meeting standards of scientific plausibility and technical adequacy. Relevance refers to the fit between the information produced and the specific needs and logistical constraints of the diverse stakeholders. Legitimacy refers to whether the process for determining research needs and methods meets standards of political and procedural fairness.

What follows is an analysis of a competitive grant process that took several initial steps in an attempt to address lessons learned from Cash et al (2003) as well as the NRC 2006: in particular, the goal of better involving intended users in the research. The focus of this analysis is to understand the extent to which a subset of projects funded by this process actually linked research to decisions. Further, the study seeks to understand the predominant factors at play in linking research to decisions. Finally, this analysis focuses in on what funding organizations can do to better link research to decisions.

Background

The funding organization used in this case is the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), which was a partnership between the University of New Hampshire (UNH) and the National Oceanic Atmospheric Administration (NOAA). CICEET began in 1997 and ended in 2012. CICEET's purpose was to fund applied research, working in partnership with the National Estuarine Research Reserve System (NERRS), in order to address pressing coastal resource issues. Expectations were that research funded by CICEET would begin to produce societal dividends within several years after project completion. In other words, the focus of the program was extremely applied.

After several years of funding projects, CICEET staff—which includes the author—began to notice that many of the projects that were technically successful were, however, not linking to decisions and decision makers to the extent that CICEET staff had hoped. This was by no means a thorough and rigorous assessment. However, CICEET staff had compelling anecdotal evidence that research that could have linked to decisions simply wasn't linking. CICEET staff decided to try to alter its program activities, especially the design of its Request for Proposals (RFP) and review processes.[1]

Up to this point, CICEET's approach to funding research was fairly typical of many applied research programs. CICEET staff read workshop proceedings and broad surveys of "users." An RFP was then written that asked for research that could be applied to pressing coastal/estuarine issues, such as habitat degradation and water quality impairments. (For the complete text of the RFP, Appendix A.) However, the criteria and the evaluation procedures were all heavily focused on the technical standards of the biophysical or engineering science contained in the proposal. None of the peer reviewers or panelists had backgrounds in education, social science, participatory processes or other disciplines that could be brought to bear on linking science to decisions.

The RFP that is the subject of this analysis was released in 2006 and was titled "Land Use Planning Tools." The RFP called for innovative application of land use planning tools, and projects that could also include research and development. We also asked that projects include a training component (targeted to planners), and dissemination of information to targeted audiences. Importantly, the RFP stipulated that

[1] For a much more detailed discussion of CICEET, including a more formal assessment of the use of CICEET-funded research, see Riley et al (2011).

applicants needed to demonstrate that they were working with a municipality that was ready, willing and able to work with applicants on the project. The RFP narrative structure asked applicants to talk specifically about the "community context" of the work, demonstrating involvement of appropriate local officials in the project activities.

We received over 30 proposals. Each proposal was reviewed by four panelists (though all panelists did not read every proposal as there were too many proposals submitted for this to occur). Panelists came from a range of backgrounds: academia, non-profits, private sector, etc. Most panelists were strongest in the technical challenges of developing and applying land use tools. While some panelists were strong in education and outreach, no participatory process experts were used. Thirteen 2-year projects were funded. The projects began in the Fall of 2007 and were completed in 2010.

This article focuses on three of those 13 projects. (See Table 4 below for more information on those projects.)

Methods

Analytical Framework This analysis employs a qualitative cross-case study approach (Yin 2003). I use the term "qualitative" in the sense of Yin (2003) to indicate that I am not entering the study with any pre-conceived hypotheses that I am hoping to prove or disprove. Rather, I have identified a phenomenon of interest—that is, linking science to decisions—as well as some specific research questions concerning that phenomenon. The research questions were:

1) To what extent have the projects linked to decisions?
2) In the case of these projects, what funder actions either led or would have led to better linking of science to decisions?

3) What benefits are seen as a result of the interactions between investigators and intended users?

4) What challenges are encountered regarding the interactions between investigators and intended users?

Table 4: Attributes of the three research projects: case studies 1 through 3.

	Case 1	**Case 2**	**Case 3**
Project	Integrating Geospatial and Web-Based Tools for Land Use Planning in New Hampshire	Tool for Restoration and Cumulative Effects Assessment in Puget Sound, WA	Planning for Lake Superior Coastal Communities, WI
Objectives	• Refine existing land use forecast and impervious surface models • Design web based tools for displaying maps related to development pressures and threats to natural resources • Make data products accessible to user community	• Integrate existing hydrodynamic model into new context • Engage stakeholders in adapting model into planning tool • Provide training and dissemination of tool to users.	• Augment geospatial data relating to watershed management • Estimate impact of various growth scenarios on natural resources • Provide training to local planners on use and access to data
2-Year Budget	236,140	262,987	170,865
Key Personnel	Principal Investigator (PI) = GIS Specialist 6 co-investigators (3 are GIS/Web specialists; 3 have expertise in user engagement)	Principal Investigator (PI) = Physical Scientist 8 co-investigators (7 are physical/natural scientists; One has expertise in user engagement)	PI = Educator 12 co-investigators (6 helping with data acquisition and interpretation); 6 helping with user engagement)
Scientific Activity Person Efforts (months)	13	7	9
User Engage Activity Person Efforts (months)	4	Less than .5	10
User Engagement Activities	• 2 stakeholder workshops • Multiple informal communications	• 2 stakeholder workshops • Multiple informal communications	• Multiple stakeholder meetings • Multiple stakeholder trainings • Multiple outreach efforts via boat tours

Linking science to decisions is a complex phenomenon with potentially many factors, some of which cannot be predicted by the researcher, making a hypothesis-based approach challenging. In addition, the case study approach enables the researcher to delve deeply into the details of each project to better understand what exactly happened during the project and why (Yin and Moore 1994; Yin 2003). For this particular case study, a key decision point for this study was whether to use the cross-case study format or rather to focus on a single project. The former allows the researcher to look for recurrent patterns in all three cases, which can add strength to the findings (Yin 2003). The tradeoff, however, is that the search for patterns across all three case studies takes away from the amount of analysis done on each individual case. For this work, the decision was ultimately made to look at three case studies, rather than one.

For each case study, four project participants were interviewed: two from the project team and two "users": that is, people who were specifically identified as being likely users of the research or tool being produced. When possible, the two project team interviewees represented someone charged with generating knowledge related to the land use planning tool or science as well as someone charged with focusing on how to link the research with decisions. In previous work (Riley et al 2011), it was shown that scientists and users can have very different perspectives on the same project, so getting both sides of the story is critical.

<u>Interviewee Selection</u> Choosing the two project team investigators to interview was fairly straightforward. Due to the nature of the RFP, it was very clear who on the project had responsibility for the tool or science development and who had more responsibility attached to actually linking science to decisions. With regard to choosing two people from the target user audience, the initial research proposals were used so that I could suggest some names to the project investigators. In communicating with the project

investigators, I often asked, “Of the following users, please name two who you would especially want to actually use and be satisfied with this tool given that you want this tool to have maximum benefit on coastal resources.” In addition, sometimes the users had moved on to other jobs or locations so that it could be more difficult to interview the most appropriate user.

Table 5: Questions asked of project investigators and intended users.

Interview Questionnaire
1. When you think about the way science is currently conducted in comparison with how it's been conducted in the past couple of decades, do you see any significant trends? (Reminder: I am particularly interested in science that has been done with the intent to inform natural resource management.)
2. In your opinion, what accounts for the difference between the past and the present, with regard to how this science is conducted? (if applicable)
3. Thinking about the future (next 10 to 20 years), do you think the trend you identified above will continue? If not, why not? If yes, why?
4. If you could prescribe changes to how science is conducted in order to maximize the extent to which scientific information is generated and used for natural resource management, what steps would you prescribe?
5. To what extent were the implementers of the research and the intended users of the research both involved in the following four steps? Framing of the problem; Design of the research approach; Implementation of the research; Linking of research results to management decisions.
6. Do you think interactions between investigators and intended users were beneficial to the goals of the project? How could they have been more beneficial?
7. Were there any negative or challenging aspects to the interactions between project investigators and intended users?
8. As far as you know, has this project influenced natural resource management decision making? (We understand that this may not be a clear-cut “yes” or “no” answer. Therefore, please explain your answer with specific examples.)
9. In your opinion, will this project influence natural resource management decision making in the future? (We understand that this may not be clear-cut “yes” or “no” answer. Please explain your answer with specific examples.)
10. In your opinion, in the context of this project, what are the most important factors influencing the extent to which the research influences decisions?
11. Are there steps that the funding agency, scientists or intended users can take to increase the extent to which research influences decision making?

<u>Data Collection and Analysis</u> Interviews were conducted using a semi-structured format so that I could follow-up or ask unscripted questions when it seemed required for understanding the phenomenon of interest. Table 5 above shows the questions that were analyzed for this study. All interviews were conducted over the phone. Interviews

were recorded using Garage Band software on a MacBook Pro computer. These electronic files were then exported to NVIVO 9.0, a qualitative research analysis software package that facilitates the organization and analysis of qualitative data. This process is often referred to as "coding," which simply refers to the placing of parts of the interview (e.g., sentences, paragraphs, etc.) into labeled categories in terms of how they relate to the phenomenon of interest.

For this study, I used the research and interview questions to create a framework to hold the specific categories. These "parent categories" consisted of: "extent of linkage," "funder actions that increase linkage," and "benefits/challenges to interactions between investigators and users." Within these parent categories, specific categories were created as they emerged from the data, as opposed to being pre-determined. For example, the following transcript quotation comes from one of the three case studies: "When you're done with the research you're doing, you really have to make an effort to communicate it to the public."

Since no codes yet existed within the parent categories, I created a new categories within the "funder actions that increase linkage," parent category. This new "sub" category was labelled "take time to communicate findings." For subsequent transcripts, I could code data to this existing category or create new ones if the existing categories were inappropriate (see Figure 3 below). Consistent with the grounded theory approach, creation and analysis of categories is an iterative and dynamic process as more and more data is gathered. Categories may be renamed and or divided into two if it serves to provide better explanations of the phenomenon being studied (Strauss and Corbin 1990; Charmaz 2006).

As one can imagine, many coded categories can and do arise as interviews are analyzed. How then does one decide which categories are most important? In contrast with quantitative approaches, which often involve statistical analyses, the qualitative approach seeks to focus on those explanations that 1) provide the closest fit with

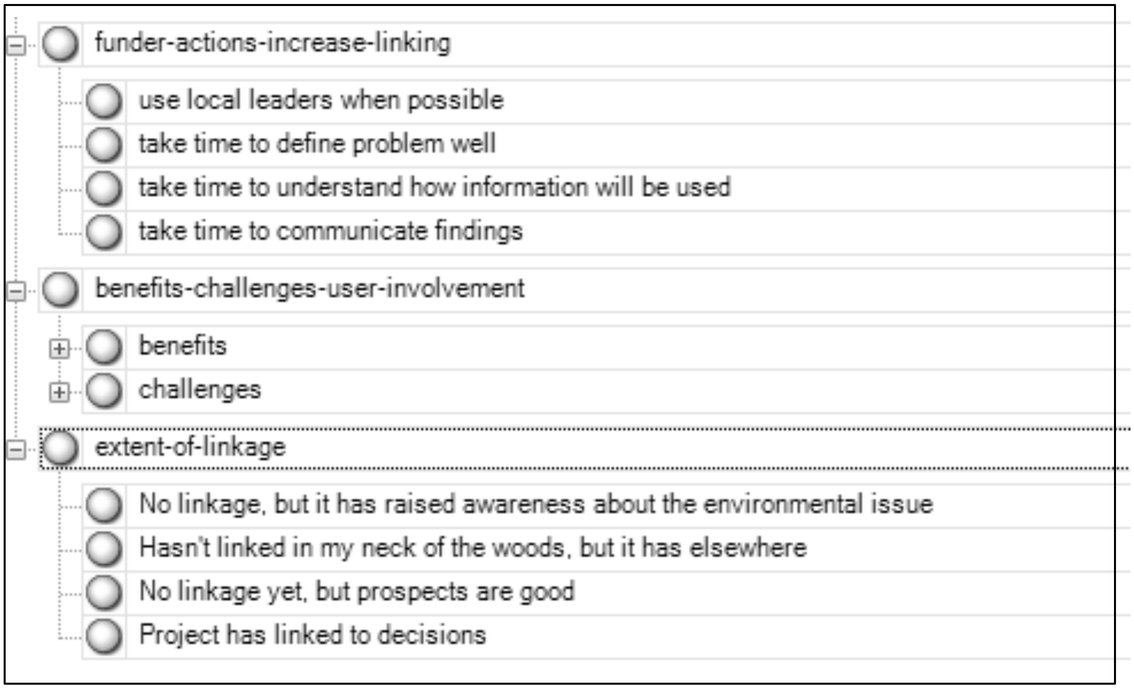

Figure 3: Screen capture image showing the development of parent and sub categories related to the research questions. In this case, the parent categories were created ahead of time as a framework for the sub categories, which emerged from the data and were not planned a priori.

the data; 2) are most useful and 3) explain the most about the phenomenon (Strauss and Corbin 1990; Charmaz 2006).

Using these criteria, I usually focus on those ideas that emerge most often. Does this mean that the ideas mentioned by fewer people have less validity? I do not believe so. However, in the final analysis, funders need to target those ideas that have the highest likelihood of being relevant. Also, with regard to linking science to decisions, perceptions of what is true—whether true or not—are worthy of consideration. Science links to decisions through people, and people's perceptions are what provide and remove opportunities for linking. Therefore, if an idea seems to be held by multiple people across multiple case studies, I assert that it may warrant more attention from funders.

Caveats Related to the Methods First, I acknowledge that interviewing two project participants does not allow me to generalize findings to a population of 25 or more participants who may be involved in a project. Rather, it allows me to gain insights into the thoughts and experiences of a sub-sample of the population. Also, the feedback from these interviewees does allow me to "generalize to theory" as noted by Yin (2003). Here, a theory—in this case, the Cash et al (2003) theory of attributes that lead to better linking of science to decisions—is used as a template with which to compare empirical results of a case study.

Second, it is important to point out that this researcher also worked for CICEET as a program manager between the years of 2000 and 2012, helping to write the RFPs and run the review processes. Some may believe this disqualifies this research as being "subjective." However, within grounded theory as well as other policy sciences disciplines such as action research (O'Brien 1998) and natural resources policy studies (e.g., Clark 2002), the researcher can both study and be a participant in the phenomenon being studied at the same time. In grounded theory, the specialized knowledge of the researcher is referred to as "theoretical sensitivity" and this is brought to bear to improve explanations for the observed phenomena. In my case, as a program manager by profession, I have an advantage in taking various kinds of feedback and translating that feedback into options for other program managers. At the same time, I have to be transparent about my biases, which have the potential to distort the explanations.

In this case, my bias, based on experience as well as my own personal orientation towards natural and social sciences, is that many applied science funding programs under-emphasize the human dimension aspect of natural resource problems.

In my view, this is mostly done due to convention and the history of science and technology policy in this country, which has put much more emphasis on generating new knowledge and much less emphasis on diffusing that knowledge to foster natural resource management problem solving (Tornatzky 1990; Ruegg and Feller 2003).

As in any scientific endeavor, researcher bias can be a threat to the internal validity of the research. Explicitly acknowledging this bias is an important part of putting my findings in a context for determining their validity. In addition, by triangulating between my observations and those of the project investigators and those of the project users, and by focusing on explanations that are consistent with all three perspectives, I hope to increase the strength of my case study findings (Yin 2003).

Finally, it must be acknowledged that the interviewees themselves have their biases. While some effort was chosen to get a diversity of biases, the population I had to choose from—the people participating as intended users—is constrained by the choices of the investigators as well as the participants themselves. Therefore, there are undoubtedly many biases that have not been included in this study.

Results

In reviewing the study results, lessons learned from each individual case study are first presented, relating results directly back to the research questions. In the last part of the results section, results from the cross case analysis will be presented, emphasizing any explanations that apply to all or multiple cases.

Case 1: Web-Based Tools for Planning in New Hampshire In Exeter, NH, near the Great Bay Estuary, rapid population growth and changing land use are impacting coastal and estuarine habitats. Project investigators proposed developing a prototype web-based mapping tool to allow decision makers to rapidly access, visualize, and synthesize a suite of natural resources data layers necessary to make decisions regarding a particular parcel/s. The tool was designed to provide a context for each parcel being considered, so that the natural resource values of the surrounding landscape are taken into account during the decision-making process. It was also meant to allow decision makers to produce a consistent report for each particular parcel/area and more effectively answer any questions about those parcels. As envisioned, the tool wouldn't require any special skills to use, and would be publicly available and easy to use, with built-in instructions that guide the user through the process. Although the tool was not produced as originally envisioned, aspects of the tool can be found at the web site http://granitview.unh.edu/

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (a GIS specialist), Investigator 2 (a GIS Extension specialist), User 1 (a municipal town planner), User 2 (a regional planner).

<u>Research Question 1: To what extent has the project linked to decisions?</u> For this project, all four interviews were in agreement that this project did not link to decisions within the expected time frame (see Table 6, below). The investigators were hopeful that the project raised awareness amongst planners, which would, in turn, help with regard to decisions. But there was no evidence from the users that this had taken place by the end of 2010. (This project began in the fall of 2007 and ended in the spring of 2010.) In addition, investigators were hopeful that the work would translate to making other tools better, and pointed to evidence that this was taking place. See http://granitview.unh.edu/ for examples of how parameters such as floodplains, soil characteristics and information about wildlife are incorporated into a web-based map.

<u>Research Question 2: In the case of these projects, what funder actions either led or would have led to better linking of science to decisions?</u> All four interviewees agree that that this project did not link to decision making because there wasn't a

Table 6: Categories relating to the four Research Questions: NH project. In this table, I1 and I2 refer to the two investigators; U1 and U2 refer to the two users interviewed.

Coding Category – RQ1: Extent of Linkage	Interviewee
No linkage yet, but prospects are good	I1, I2
No linkage	U1, U2
Coding Category – RQ2: Funder Actions	
Take the time to communicate the findings	ALL
Make sure there's engagement at all project stages	I1, I2, U1
Take time to understand how the info/tool will be used	I1, I2, U2
Encourage more visiting of each other's different worlds	U1
Make sure projects set realistic goals	U2
Make sure the engagement is actually funded	I1
Need more funding for research overall	U2
Take the time to define the problem well	I2
Coding Category – RQ3: Interaction Benefits	
Aligns investigator and user perceptions of what's needed	I1, I2, U1
Generates enthusiasm for the research among users	I2
Generates understanding of the research and env. issues	I2
Coding Category – RQ4: Interaction Challenges	
Reconciling different expectations re complexity & workload	I1, I2
Users frustrated working with beta versions of info/tools	U2
Can slow down the research considerably	I2
Finding time to complete sufficient iterations of tool/info	U1
Getting busy users to respond	I2
Getting real engagement before the project is awarded	I2
Determining how many users to include in project	I2

useable tool by the time the funding dried up. There is also agreement that the project ran out of time because approximately halfway into the project, users made comments about the attributes of the tool that necessitated a significant reframing of the design. Hence, the project could not be completed on time.

In terms of what funders could do to influence this situation, Table 6 indicates that, in addition to more communication, there needs to be more engagement throughout the project and more concerted thought in terms of how the research will be used. Investigator 2 noted:

> Having engagement and outreach as an integral part of an RFP and a grant stream is crucial, because you don't see that very much in a lot of federal agencies, and if you do, and this is coming from someone who works in extension who also does some research-based, more basic science, if you do see it, it's often lip service.

Both investigators noted that engagement had to be built into the process via the RFP and then the proposal itself. Here, Investigator 2 notes that this is easier said than done:

> In an ideal situation, you would do that [have detailed conversations about the problem definition and design approach] before the proposal was even entered, but you can't do that, and people don't have time to do that until they have the proposal funded. So that's the Catch-22. How do you have that type of thing happen before the project even starts? And you can do that, and we tried to, but it's different once the project is going and you sit down with people. Even if we had a similar type of meeting before. That's the trick for a funding group or any organization.

In this case, the investigator noted that they were able to have some conversations with the intended users during the proposal stage, but “it's a little bit different when six months or a year later, you sit down with them and really talk with them specifically.”

Investigator 1 focused on the funder’s influence over budgets. “I think the funding agency, and I think it seems like that was something that CICEET was doing already, and that's to allocate more resources to the engagement aspect, and require that scientists incorporate that specifcially into the project. So, to me it starts with the funders.” One of the users echoed this sentiment in a more general way, noting that funding “in this area” needed to be expanded.

<u>Research Question 3: According to the interviewees, what benefits are seen as a result of the interactions between investigators and intended users?</u> As indicated in Table 6, the primary benefit of interactions between investigators and users is to better align ideas between the two groups about what is actually needed by managers. For this project, there was a consensus around the idea that more frequent engagement throughout the project would have better aligned perceptions of need and use, and the research may have seen more use in the given time frame. User 1 noted: “Before the product was at its completion, it needed more trial runs, and I don't know if you could

have done that, but by the time we were asked to review it, we weren't given that much time...we needed more time dedicated to review and improvement of the product.”

Research Question 4: According to the interviewees, what challenges are encountered as a result of the interactions between investigators and intended users? As indicated in Table 6, the primary challenge for this project was the sense of investigators and users having a different understanding of how much work was expected of them. Investigator 2 noted:

> So that can also be a challenge is just getting everybody on the same page and having them be realistic about the amount of time and effort that they have to put in to something versus the benefits they're going to get. That can be tricky. Whereas if you have a group of scientists and high-level resource planners, they might not take as much guidance in bringing them along.

Case 2: Tool for Habitat Protection, Restoration and Cumulative Effects Assessment in Puget Sound, WA The Whidbey Basin in WA state is under pressure from increasing population and development of its natural resources and infrastructure. Currently, and over the last century, many development and restoration projects have occurred that do not adequately take into consideration cumulative effects. One of many ecological endpoints of major concern is the health of the local salmon population. The purpose of this project was to design, develop and begin to implement a unifying hydrodynamic modeling to be used for habitat restoration for salmon recovery. Specifically, this modeling tool provides an assessment of hydraulic and coastal engineering feasibility. In addition, a particle tracking model and user-friendly animations allowed parameters like connectivity, migration pathways and access to be evaluated to help quantify the potential for overall restoration success. For more information see Table 4 as well as Lee (2010).

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (a lead scientist and hydrodynamic model developer), Investigator

2 (an applied scientist and outreach specialist), User 1 (a scientist for a Native American tribe organization), User 2 (an executive administrator for a watershed group focused on salmon).

Table 7: Categories relating to the four Research Questions: WA project. In this table, I1 and I2 refer to the two investigators; U1 and U2 refer to the two users interviewed.

Coding Category – RQ1: Extent of Linkage	
Project has linked	I1, I2, U1
Has linked elsewhere but not in my vicinity	U2
Coding Category – RQ2: Funder Actions	
Make sure the science is high quality	ALL
Take the time to communicate the findings	I1, U1, U2
Encourage more visiting of each other's different worlds	I2, U1, U2
Make sure the information/tools are available	I1, U1
Make sure the engagement is actually funded	I2
Be clear regarding expectations to link to management	I2
Demand interdisciplinary project teams	I2
Look to leverage government pressure, regulations	U2
Make sure there's engagement at all stages	I2
Provide training for teams interested in collaborative research	I2
Set the goal of creating and/or nurturing relationships, trust	I2
Support liaisons between research and user communities	U1
Take time to understand how information will be used	I2
Coding Category – RQ3: Interaction Benefits	
Aligns investigator and user perceptions of what's needed	I1, U1
Generates enthusiasm for the research among users	I2
Generates enthusiasm among investigators for collaboration	I2
Generates understanding of the research and env. issues	I2
Created new and valuable relationships	I2
Creates opportunities to share information	U1
Coding Category – RQ4: Interaction Challenges	
Finding time to complete sufficient iterations of tool/info	I2, U1
Misunderstandings due to differences in way of communicating	U1

Research Question 1: To what extent has the project linked to decisions? Table 7 above indicates that all four interviewees thought that this work would link to natural resource management decisions in the future and only one person (User 2) didn't think that the project had already linked to decisions by the time of the interview (Fall 2010). User 1 noted: "Yes, it has absolutely affected decision making. It has affected how we've started to fund other restoration projects in the whole delta, because we're looking at cumulative impacts and realizing these cumulative impacts of all the restoration projects in the area; it's kind of driving our overall thinking about restoration in the delta." The impact of the project was echoed by Investigator 1, who said:

> This actually may go down as one of the projects for which we have clear answers [for that question]…there's a general acknowledgement in the community, that a good quality hydrodynamic model of the entire estuary is available, so if anybody wants to make changes to the estuary, they should test it out with the tool that we built. And each new project adds more data and that becomes the existing model of the estuary.

<u>Research Question 2: In the case of these projects, what funder actions either led or would have led to better linking of science to decisions?</u> Table 7 indicates that all four interviewees noted the importance of having high quality science. User 1 noted: "The most important factor is the validity of the model and the results. If the results are good, people will use it. And people are very critical of the science that is used in decision making and so I think that's by far the most important factor is that it describes the system well enough to be trusted."

In addition, three of the interviewees noted both the importance of communicating the findings as well as doing more to get researchers and users to visit each other's worlds more often. Related to communication, User 2 noted: "I think by and large it's the way the information is disseminated. I think that is what invariably is not conducted in any meaningful way. [This work] was the closest that I have come in my tenure here to seeing information being translated in ways that the majority of non-scientists could understand." User 2's assertion that this project did an unusually good job at dissemination is underscored by User 1's comments on the power of the visual animations produced: "In this case, [the investigators'] animations were invaluable to the process. In fact, they're probably the most important thing because it's seen the most. So, tools for presenting data in new ways are really, really important."

Related to researchers and users living in different worlds, Investigator 2 noted: "In terms of interactions that could be more beneficial, I think mainly just the ability to have more interactions. When we had our one big workshop, it was great, but there were probably certain people who couldn't be there—it was just one day and that was it—so we needed more of the same."

Table 7 shows that Investigator 2 sees the funder as having a critical role in building more bridges between researchers and users. The following excerpt sums up this sentiment:

> To me, the overriding thing here is time. Nobody ever has enough time, and all the things I've talked about in terms of being able to build better relationships, knowing what's going on; the managers need to know what science is plausible, possible; the scientists need to understand the manager perspectives, etc.; the intended users need to understand what's available, who's doing good science, etc. It speaks to just finding time that these people can all be together. Unfortunately, it comes down to the funding agency, because time is money. [Funding agencies have to] create opportunities for these kinds of interactions to happen. It's funding of workshops, funding of interactions and there are a lot of creative ideas about how this can be done."

Research Question 3: According to the interviewees, what benefits are seen as a result of the interactions between investigators and intended users? Table 7 shows that two of the four interviewees (one investigator and one user) noted that investigator-user interactions align perceptions of what's really needed. For example, User 1 noted: "We did do some collection of data together and went out to the field and that become invaluable to their research because then they framed the model correctly. Bringing it down to a small scale, you needed a lot of modifications to the model that they used." Investigator 2 noted four other interaction benefits, including the creation of new relationships.

Research Question 4: According to the interviewees, what challenges are encountered as a result of the interactions between investigators and intended users? As in the NH case, interviewees (one investigator and one user) noted that there was not quite enough time to get comfortable and review the tool (see Table 7). Investigator 2 noted: “Came down to time again. As you know, doing good relationship building and outreach takes a lot of time. And in this project, in particular, we didn't have a lot of time, so we just had to make it as effective as possible. It wasn't bad, it was just very challenging to do it in the time available.”

<u>Case 3: Planning for Lake Superior Coastal Communities, WI</u> In the Lake Superior basin in Northwest Wisconsin, development pressures have been leading to impacts on water resources. In particular the wetlands in the basin have been identified as being critical for ecosystem health. While some initiatives have targeted smarter land use planning, much of the information is not getting to key decision makers. In addition, much of the critical geospatial information is not located in a centralized location nor are many of the map layers compatible. The goal of this project was to implement several critical geospatial analyses and make the data available to planners via the Douglas County web site. Analyses include forest cover, impervious surface, land use impact and hydrologic analysis on a sub-watershed scale. Information from this project was used to identify goals and objectives in the Douglas County comprehensive plan especially with regard to the natural resource and land use elements that would provide the foundation for protection of stream and coastal water quality. For more information on the County’s GIS resources or the land and water conservation plan related to this project, visit http://wi-douglascounty.civicplus.com/index.aspx?nid=305

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (an education specialist), Investigator 2 (a GIS specialist), User 1 (a Douglas County, WI, planning administrator), User 2 (a Douglas County land use planning volunteer).

Table 8: Categories relating to the four Research Questions: WI project.
In this table, I1 and I2 refer to the two investigators; U1 and U2 refer to the two users interviewed.

Coding Category – RQ1: Extent of Linkage	
No linkage yet, but prospects are good	I2, U1
Project has linked to decisions	I1, U2
Coding Category – RQ2: Funder Actions	
Take the time to communicate the findings	ALL
Take the time to define the problem well	I1, U1
Take time to understand how the info/tool will be used	I2, U1
Encourage more visiting of each other's different worlds	I1, U2
Set the goal of creating and/or nurturing relationships, trust	I1, U2
Make sure there's engagement at all project stages	I1
Make sure the science is high quality	U1
Need more funding for research overall	U2
Use local leaders when possible	U2
Make sure educational institutions can access funds, too	U2
Fund people with a track record of being positive collaborators	U2
Coding Category – RQ3: Interaction Benefits	
Generates understanding of the research and env. issues	I1, I2, U2
Aligns investigator and user perceptions of what's needed	U1
Creates opportunities to share information	I2
Helps create consensus around complex issues	U2
Coding Category – RQ4: Interaction Challenges	
Can slow down the research considerably	I1
Some users may try to thwart the process	I1
There's a shortage of funding for interaction	I2

Research Question 1: To what extent have the projects linked to decisions? Two of the four interviewees thought that this work would soon link to natural resource management decisions (see Table 8 above), while two of the users felt that the work had already begun to bear fruit, noting that heightened awareness of conditions and threats—due to this project—had already made it easier to make conservation decisions in Douglas County. While most of the comments made it clear that the real impact was yet to occur, comments about the project's potential were fairly emphatic. For example, User 2 said: "I think that this comprehensive land use planning project has made all the members of the current board aware of some of the shortcomings, dangers facing our environment, some of the things that are coming down the pike that we need to be ready for and that we need to hopefully prevent." Investigator 1 noted: "One of the most obvious examples [of use] was bringing the planning committee to the point where they understand that there are steps they need to take to make sure that the stream water quality in their town stays as good as it is, or could possibly be improved upon. There was a lot of assuming that that would always just be there."

Research Question 2: In the case of these projects, what funder actions either led or would have led to better linking of science to decisions? Eleven different funder actions emerged from the qualitative analysis (Table 8), but only one was noted by each of the interviews: take the time to communicate the findings. As User 2 put it:

> We have a smaller and smaller circulation for our newspaper. I don' t know how to get information out; it's a difficult thing. I guess we work through schools and our scientists. But pick people that can present in a way that people understand. Obviously, funding is important, but you need to get people to see it and understand it and learn about it.

Investigator 1 described the communication need this way: "…interpreting what the bottom line was for the county, or the towns, or the land owners. That's what they wanted to know. That's what we had to work the hardest at is, you know, sometimes bringing it down to that level."

In addition, there were four funder actions that were mentioned by two of the four interviewees. Investigator 1 and User 1 noted the importance of "Taking the time to define the problem well." User 1 notes: "The funding agency [needs] to be patient enough to do the hard government work of taking the time to…get public input on the question as you're formulating the strategy to achieve the desired end state." Investigator 2 and User 1 also talked about thinking more carefully about how science will get used. Investigator 2 notes: "First of all, a lot of science nowadays, especially in the Great Lakes Region...there isn't always a need for that science. And if there is, there's not a demanding need." Investigator 1 and User 2 talked explicitly about relationships and trust. User 2 said: "The fact that the research was done by a local college, and people that live here and care about our community. It's not something that came from far away. I think that's really important. The researchers have a stake in our community." Finally, as noted in both of the earlier cases in NH and WA, multiple interviewees noted the need to create more ways for researchers and users to cross paths and exchange information.

Research Question 3: According to the interviewees, what benefits are seen as a result of the interactions between investigators and intended users? For this case, three of the four interviewees converged on one interaction benefit (see Table 8): "generates understanding of the research project and environmental issues." User 2 said: "Sometimes people don't even know there's a problem and the idea of the relationship between how we manage our forests and this problem that our land conservation committee deals with all the time, with run-off and degradation. So, I think they made the people on the committee aware of what the problem was."

Research Question 4: According to the interviewees, what challenges are encountered as a result of the interactions between investigators and intended users? Three challenges were noted by the interviewees, each one mentioned by only one interviewee: "can slow down the research considerably," "some users may try to thwart the process," and "there's a shortage of funding for interaction." The first two challenges were mentioned by the same interviewee and were linked; people trying to thwart the process—e.g., by challenging and then refusing to accept the basic assumptions of the project—slowed the research down because the project team had to essentially wait these people out. Investigator 1 said: "That was probably the most challenging thing, having to deal with those folks that may have gotten on these committees to slow things down a little bit. But we were able to work around that; it just took us more time."

Results Across the Three Cases: Did Projects Link to Decisions? For two of the three projects, interviewees agreed that the projects linked to decisions and/or showed

Table 9: Cross-case listing of all categories for the four research questions.

Coding Category	**# of people (n=12)**	C1 NH	C2 WA	C3 WI
Category – RQ1: Extent of Linkage				
Project has linked	5	0	3	2
No linkage yet, but prospects are good	4	2	0	2
Has linked elsewhere but not in my vicinity	1	0	1	0
No linkage	2	2	0	0
Category – RQ2: Funder Actions				
Take the time to communicate the findings	11	4	3	4
Foster more visiting of each other's worlds	6	1	3	2
Try to understand how the info/tool will be used	6	3	1	2
Ensure engagement at all project stages	5	3	1	1
Make sure the science is high quality	5	0	4	1
Set goal of nurturing relationships, trust	3	0	1	2
Take the time to define the problem well	3	1	0	2
Need more funding for research overall	2	1	0	1
Make sure the engagement is actually funded	2	1	1	0
Make sure the information/tools are available	2	0	2	0
Make sure projects set realistic goals	1	1	0	0
Be clear regarding linking expectations	1	0	1	0
Demand interdisciplinary project teams	1	0	1	0
Leverage government regulations, pressure	1	0	1	0
Offer training for doing collaborative research	1	0	1	0
Support liaisons for linking research & users	1	0	1	0
Use local leaders when possible	1	0	0	1
Ensure educators can access funding, too	1	0	0	1
Fund those w/ history of positive collaboration	1	0	0	1
Category – RQ3: Interaction Benefits				
Aligns investigator/user ideas of what's needed	6	3	2	1
Generates understanding of research & issues	5	1	1	3
Users more enthusiastic about the research	2	1	1	0
Creates opportunities to share research	2	0	1	1
Investigators more enthusiastic re collaboration	1	0	1	0
Created new and valuable relationships	1	0	1	0
Creates consensus around complex issues	1	0	0	1
Category – RQ4: Interaction Challenges				
Finding time for enough iterations of tool/info	3	1	2	0
Can slow the research down considerably	2	1	0	1
Frustration for users in trying beta versions	1	1	0	0
Getting busy users to respond	1	1	0	0
Getting engagement before project is funded	1	1	0	0
Deciding how many and which users to involve	1	1	0	0
Confusion due to communication differences	1	0	1	0
Some users may try to thwart the process	1	0	0	1
There's a shortage of funding for interaction	1	0	0	1

promise of linking in the future (see Table 9 above). For the NH project, the investigators felt more confident than the users about future linkage. Interviewees from all three projects noted that—in hindsight—improvements could have increased the extent to which the science linked to decisions.

Results across the three cases: RQ2, funder actions Table 9 shows that a total of 19 categories arose from the qualitative analysis, related to what funders can do to better connect science to decisions. “Take time to communciate findings” was clearly the most common suggestion overall, arising almost twice as much as the next most common category. Of the 19 categories, only four actions were mentioned in all three projects: “take time to communicate findings,” “foster more visiting of each other’s worlds,” “try to understand how the info/tool will be used,” and “ensure engagement at all project stages.”

Results across the three cases: RQ3 & 4, interaction benefits/challenges Seven benefits arose in total (Table 9) from the qualitative analysis, with only two of those benefits coming up in all three projects: “aligns investigator/user ideas of what’s needed” and “generates understanding of research and issues.” In terms of challenges, nine issues arose in total across all three cases, with none of these challenges coming up for all three projects. In addition, only two of the challenges arose in more than one project: “finding time for enough iterations of the tool/information,” and “interactions can slow the research down considerably.”

Discussion

This analysis is an empirical study of a competitive grants process that was designed to better link science with decisions. By focusing the RFP on a specific issue and by requiring certain project attributes (e.g., partnering with a municipality or other community), program managers hoped to better link science with decisions *during* the project in the belief that this would translate to more use *after* the project was completed.

In other words, there are some important assumptions that distinguish this kind of applied research from equally valid kinds of applied research. First, there is an explicit component of urgency to the process; that is, problems are considered time senstive and some progress during the project is desired, as opposed to progress decades in the future. Ziegler and Ott (2011) refer to this urgency specifically as a critical ingredient of sustainability science. Second, there is an assumption, albeit based on a signficant amount of empirical research (e.g., Beierle and Cayford 2002; Cash et al 2003, NRC 2006) that early involvement of intended users may correlate with greater linking of science to decisions after project completion. This research and analysis then places a high value on projects that begin to show links between science and decisions during the project.

For two of the three studied projects (WA and WI), interviews indicated that both investigators and users felt the research was linking to decisions or would soon. In addition, there is some evidence that the particular nature of the RFP may have had an impact. Although interviewees were not asked explicitly to judge the value of the program or the RFP in terms of linking science to decisions—because such a question was considered leading—both of the investigators from the NH and WA projects volunteered comments about the nature of the RFP and the impact it had on the project. For example, Investigator 2 from the NH project noted: “The way our project went was that the project, as put forward by CICEET, was that you had to involve the stakeholders along the way. It can’t just be something you do at the beginning.”

At the same time, the interviews provided evidence that all three projects, if given the chance to repeat the experience or to control the way the funds were distributed, would have made some changes to better link science with decisions. This evidence points to the assertion further explorations and tweaks to the funding mechanism are warranted to increase the extent to which the science links with decisions.

Many science agencies run competitive grants programs that mainly emphasize the creation of credible information and tools. The RFPs and the review processes, including the weighting criteria, tend to prioritize the generation of credible science. Yet Table 9 shows that with these three projects, scientific credibility was only of the critical ingredients of successfully linking science to decisions. Topics that received more attention included: user engagement throughout the process, more effort towards effective communciation of findings, etc. (Table 9).

The message is NOT to flip the current proportions and begin to underemphasize the credibility of the science. Rather, funders should continue to adjust the system to move toward greater balance so that those activities having to do with user engagement becomes less "limiting."

The term "limiting" is borrowed from the fields of chemisty and ecology; it denotes a state or reaction that requires mutliple compounds but one tends to run out before the other. The compound that runs out first is said to be "limiting" the reaction. Based on this research, we can depict the reaction akin to a chemisty equation in the following manner:

CS + UE → SLD
Credible Science + User Engagement → Science Links to Decisions

In this equation, for these three projects, the limiting "reactant" seemed to be user engagement.

This equation is in agreement with a great deal of previous research in the science, technology and policy disciplines (e.g., Cash et al 2003; Ruegg and Feller 2003; Mog 2004; Rayner et al 2005; NRC 2006; McNie 2007; Dreelin and Rose 2008; Dilling 2011; Meyer 2011; Riley et al 2011). In particular, Ruegg and Feller (2003) have noted that the United States is renowned for being good at generating knowledge and not very good at diffusing that knowledge: a perception noted by other researchers as well (Tornatzky and Fleischer 1990; Stoneman 2002).

The model also supports an important conception put forward by Sarewitz and Pielke (2007). These authors assert that a major issue in better linking science to decisions is better reconciling the supply and demand for science. In other words, the research enterprise in the United States—and the academic system as a whole—is well set up to generate great quantities of highly credible research. What often happens, however, is that the research is more useful to the researchers than the users who, under the auspices of the grant, are supposed to benefit. The coded categories of "try to understand how the info/tool will be used" and "take the time to define the problem well" (Table 9) are in agreement with this theory.

The model is also in agreement with Cash et al's (2003) theory of the importance of trying to simultaneously increase the credibility, relevance and legitimacy of the research. In this study, two of the projects emphasized the importance of the credibility of the science (Table 9). Several different categories emphasized the relevance of the research (Table 9). The focus on relevance is in agreement with this research's result concerning the category: "Make sure science that's funded is science that's needed" (Table 9). Finally, two of the projects noted the importance of prioritizing relationships and trust, clearly related to the attribute of procedural fairness and legitimacy (Table 9).

It is important to note that Cash et al (2002) assert that the three attributes of their model can be at tension with each other. For example, efforts to increase legitimacy and relevance may result in a decrease in credibility. It is debatable whether my study's results support that assertion. Certainly, multiple interviewees noted that user engagement could be very time consuming—for example, the WI project having to wait out those stakeholder who joined the group in order to slow it down—and also that it could be very difficult or frustrating (see the description of the NH case). One could interpret this as leading to a decrease in the overall quantity of credible research, because time spent on user engagement decreases the time spent on credible research. On the other hand, there were also multiple occasions when interviewees noted that the research was made more credible through the inclusion of user knowledge and perspectives (e.g., see WA case description in "Results").

Given these results, what is a funder to do? While there are clear indications for broad directions for funder actions, these indications have mostly been mentioned before (e.g., NRC 2006, RATF 2007, NRC 2009). In order to suggest other possibilities for funder actions, let us first revisit our equation for science linking to decisions, adding some critical ingredients (in italics) under each of the necessary "compounds."

CS +	UE	→	SLD
Credible Science +	User Engagement	→	Science Links to Decisions
Expertise	*Expertise*		
Time	*Time*		
Budget	*Budget*		
↓	↓		↓
Science considered accurate	*Engagement considered effective*	→	*Science is trusted, useful, available and known to the user audience*

The traditional approach to funding highly credible biophysical research at NOAA is based on a competitive grants and review process that includes mechanisms to ensure that the project has the appropriate expertise, time, and budget for the proposal's goal, usually dealing with biophysical issues. There is an abundant literature on participatory research and natural resource decision making (e.g., Lynam et al 2007; Van Korff et al 2010) that would suggest that these same critical ingredients apply to the user engagement side of the project. Of course, this would require changing the review process to reflect a more balanced approach to linking science with decisions. For example, instead of having three biophysical science experts review the proposal, program managers may need to arrange for two biophysical experts and two user engagement experts (Matso 2012). In addition, it stands to reason that the general composition of budgets would have to change to be in line with this altered paradigm.

In addition to modifying the review process, program managers can make sure that the project team has a dedicated person whose sole job is to think about integration. This integration function is commonly referred to as a “boundary spanner” in the literature (e.g., Guston 2001; Pietri et al 2011). Boundary spanning can be achieved by requiring the presence of such a person on the project team in the RFP; alternatively, a program manager could serve this role (see Chapter 5).

Finally, another option that could provide benefits (as well as challenges) is a more iterative and flexible funding cycle. The traditional funding cycle of a competitive grants program is rather rigid and does not allow for the kind of iterative learning and experimentation that is often required when trying to come up with a creative solution to a complex problem. Numerous excerpts in the case study descriptions attest to this issue (see, especially, Investigator 2’s remarks under the NH case). Ideally, funders would be able to distribute monies to project teams in smaller increments as they continually grow and adapt their project, changing the problem definition, research design and strategies for user involvement. However, this places a heavy administrative burden on already cash-strapped funding programs. Nevertheless, some creativity and innovation in the way funds are distributed may be necessary to reach maximum potential for linking science to decisions.

Conclusions

Based on these three projects, attempts to better link research to decisions by modifying traditional project requirements had some level of success but there was certainly room for further experimentation and improvement. Interviews with project teams and users showed that funders need to think harder about how to integrate users into the research process while maintaining the high credibility of the scientific work itself. Both of these elements are necessary but insufficient on their own. Importantly, in these projects, the user engagement aspect was the limiting reactant. Equally notable, the primary tradeoff for investing in user integration was time; the research itself, based on these projects, saw increases in credibility, relevance and legitimacy due to the user involvement in the project.

My findings indicate that funders should modify their approach to funding applied science. Logic suggests they should support user integration in the same way they support strong biophysical research, and this starts with the RFP and the review process as well as involving boundary spanning entities. In addition, they should explore creative ways to make the funding cycle correspond more to the iterative way that teams and communities build momentum and learn when addressing complex problems.

My research also echoes other calls for further exploration of what funders can do and have done to better link science with decisions. This particular study's findings are based on three projects only and a limited number of interviewees. Other similar research looking at other programs and projects would help assess the generalizability of these results. Further, longer-term monitoring of projects is necessary to validate some of the assumptions of this study: namely, that strong links to decisions during the project foreshadow continuing and strong links in the years directly following a project.

More broadly, as this line of research progresses, it may be reasonable for the federal science agencies to more officially audit their research portfolios to make sure that traditional assumptions about the societal benefit of different kinds of research are still appropriate. More clear-eyed strategic thinking could help federal science agencies, in these times of tight budgets and complex problems (e.g., climate change), make sure that they are doing what they can to reconcile the supply and demand of public-sector environmental research.

CHAPTER 3

CAN FUNDERS DO MORE TO LINK SCIENCE WITH DECISIONS? CASE STUDIES OF COASTAL COMMUNITIES AND CLIMATE CHANGE

Introduction

While debate continues to rage in the political sphere about the causes of climate change as well as what society should do about it, there is a strong consensus that climate change is happening. Resource managers from towns to states to countries recognize that planning for climate change is becoming more and more necessary.

There is also little debate that science has a role to play in how our society addresses climate change. In contrast, however, there is considerable difference of opinion in how science can be employed to help society adapt to the impacts of climate change. Recently, a number of studies have called for a modified vision of how science can link to decisions, especially with regard to climate change and environmental resources (e.g., Rayner et al 2005; NRC 2009; Dilling and Lemos 2011; Meyer 2011). The main finding reported by Meyer (2011) is that science sponsors need to avoid the assumption that any advancement in understanding of climate change is, per se, beneficial. Rather, a more strategic and nuanced approach is required to ensure that scientific work actually leads to desired social outcomes.

The purpose of this study is to investigate the short-term impacts of a funding process that explicitly tried a more strategic approach than the one of focusing primarily on knowledge generation and only considering the link to societal outcomes as a lesser priority. By examining four projects funded through this unusual solicitation, this study will attempt to shed insight on what factors are most critical regarding linking science to decisions. More to the point, which of these factors can be leveraged by funders and how might funders actually go about doing that?

Background

The funding organization in question is the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), which was a partnership between the University of New Hampshire (UNH) and the National Oceanic Atmospheric Administration (NOAA). CICEET began in 1997 and ended in 2012. CICEET's purpose was to fund applied research, working in partnership with the National Estuarine Research Reserve System (NERRS), in order to address pressing coastal resource issues. Expectations were that research funded by CICEET would begin to produce societal dividends within several years after project completion. In other words, the focus of the program was extremely applied.

As detailed in Riley et al (2011), around 2005, CICEET's staff, which included myself, began to alter program activities, especially the design of its Request for Proposals (RFP) and review processes, in response to evidence that the science CICEET was funding was linking to decisions at a lower rate than originally hoped for. The RFP that is the subject of this article was the last RFP released by CICEET. It was released in 2008 and titled "Place-Based Solutions to Land Use and Climate Change Impacts." For the complete text of the RFP, see Appendix B.

The RFP (CICEET 2008a) called for science activities addressing dual impacts of land use and climate change on coastal resources and communities. In addition, proposals had to closely coordinate with staff members at one of the 28 NERRS (the Reserve system) sites around the country. The RFP narrative structure required applicants to address methods relating to biophysical research but also relating to collaboration, evaluation/adaptation and knowledge dissemination. Applicants were required to designate a “lead” for each of these four components of the proposal. In addition, it was not permissible for the biophysical lead to also be the collaboration lead.

Eighteen preliminary proposals were submitted in response to the solicitation. Six panelists read all 18 proposals, but were asked to focus on those components of the proposal (e.g., collaboration; knowledge dissemination, etc.) that most conformed to their expertise. From these 18 pre-proposals, seven went to the full proposal stage. At that stage, eight panelists read all seven proposals. Panelists came from a range of backgrounds: academia, non-profits, private sector, etc. While some panelists were strong in education and outreach, no social scientists or collaboration or participatory process experts were used. Four 2-year projects were funded, beginning late in 2009; these four projects are the subjects of this study. (See Table 10 for more information on those projects.)

Methods

Analytical Framework This analysis employs a qualitative cross-case analysis approach (Yin 2003). I use the term “qualitative” in the sense of Yin (2003) to indicate that I am not entering the study with any pre-conceived hypotheses that I am hoping to prove or disprove. Rather, I have identified a phenomenon of interest—that is, linking science to decisions—as well as some specific research questions concerning that phenomenon.

Table 10: Case study project attributes.

	Case 1	Case 2	Case 3	Case 4
Project	Assessing Vulnerability to Sea Level Rise: Coastal New Jersey	Collaborative Watershed Planning and Management: South Slough, OR	Paleoecology and Geospatial Models for Salt Marsh Management: Watsonville, CA	Assessing Risk of 100-Year Floods: Lamprey River Watershed, NH
Objectives	• Design web based tools for assessing risk and promoting preparedness and land use planning decisions in face of sea level rise.	• Envision and plan for watershed health • Choose suite of indicators to monitor system condition in face of climate change.	• Understand historical extent of salt marsh habitat • Model and visualize impacts of various future scenarios on salt marshes	• Assess impacts of land use and climate change on flood risk. • Develop new floodplain maps. • Train planners in use of new maps.
2-Year Budget	272,971	216,092	280,615	177,815
Key Personnel	Principal Investigator (PI) = GIS Specialist 4 coinvestigators (2 GIS specialists; 1 ecologist; 1 user engagement specialist)	Principal Investigator (PI) = Biophysical Specialist 12 coinvestigators (9 physical/natural scientists; 3 user engagement specialists)	Principal Investigator (PI) = Ecologist 7 coinvestigators (4 modelers and sediment specialists); 3 user engagement specialists)	Principal Investigator (PI) = Physical Scientist 7 coinvestigators (3 engineers, modelers, etc.); 4 user engagement specialists)
User Engage Activities	• 4 focus groups • 3 tool beta-testing workshops	• 4 stakeholder meetings • ~10 advisory group meetings	• 3 stakeholder workshops as well as survey work	• 4 advisory group meetings • 1 training workshop

The research questions are: 1) To what extent have the projects linked to decisions up to this point in time and what are the prospects for the project to link to decisions in the future? 2) In the case of these projects, what can funding organizations do to better link science with decisions? 3) Specifically with regard to user engagement, what can funders do to make this aspect of the project more effective?

This third research question was added to the first two because previous research (Riley et al 2011) indicated that the user engagement aspect of the project was of paramount importance in terms of linking science to decisions. By asking both research question 2 and 3, this study hopes to better understand two things: first, how important, according to interviewees, user engagement is in relation to other factors at play in a research project; second, what aspects of user engagement are most deserving of attention from funders?

For each case study, four project participants were interviewed: two from the project team and two from the user audience. When possible, the two project team interviewees represented someone charged with generating knowledge related to the biophysical science as well as someone charged with focusing on how to link the research with decisions.

In addition to the interviews, direct observation of one meeting in the second year of each project was used to add additional information related to Research Question #3, which focuses specifically on user involvement. Richards and Morse (2007) note that direct observation provides opportunities to collect data not obtainable by simply asking participants questions. For example, in some cases, participants may not be aware of their own behaviors or attitudes.

Direct observation occurred in the following manner. I was introduced at the beginning of the meeting as a staff member of CICEET who was present to observe but not to participate. I refrained from asking any questions or making any comments throughout the meeting. I used a pre-written protocol (Yin 2003) that specified the type of information I was intending to capture (see Appendix E). This included: explicitly stated purpose of the meeting; physical layout of the room; and the number of people present and their explicitly stated roles. The protocol prompted the observer to record behaviors and interactions that could have affected the linking of science to decisions, either through increasing/decreasing credibility, relevance or legitimacy (Cash et al 2003) or through any other means. With regard to the Cash et al (2003) model, credibility refers to whether all stakeholders perceive the information as meeting standards of scientific plausibility and technical adequacy. Relevance refers to the fit between the information produced and the specific needs and logistical constraints of the diverse stakeholders. Legitimacy refers to whether the process for determining research needs and methods meets standards of political and procedural fairness.

In addition, the protocol required a rating of the meeting's ability to achieve objectives related to linking science with decisions. Five ratings were possible. A "5" indicates that the meeting met or exceeded CICEET's expectations (see below) and there were no exceptions to this rule. A "4" indicates that, overall, the meeting met expectations, but there were definitely some opportunities for improvement. A "3" indicates that the meeting was mixed with roughly half meeting expectations and half falling short of those expectations. A "2" indicates that the meeting mostly did not meet CICEET's expectations, with a few exceptions. A "1" indicates that the meeting did not resemble CICEET's expectations in any way.

Interpreting these ratings requires an understanding of CICEET's expectations, which were noted in the RFP contextual information (CICEET 2008b). Essentially, CICEET asked for the execution of an explicit plan to increase the credibility and relevance of the research and to make explicit efforts to duly consider the opinions of a diversity of intended users (legitimacy).

These expectations come from CICEET staff's own experience in learning how to better run meetings to address complex issues. Over the past years, staff members have become familiar with project planning and design techniques as well as facilitation methods. For examples of these materials, see the NOAA Coastal Services Center web site (Coastal Services Center 2012). In addition, these expectations come from studying common models for addressing complex environmental issues, such as: Collaborative Learning (Daniels and Walker 2001) and Joint Fact Finding (Ehrmann and Stinson 1999). Finally, these expectations derive from watching or participating in processes facilitated by skilled practitioners.

Interviewee Selection In all four cases, choosing the two project team investigators to interview was fairly straightforward. Due to the nature of the RFP, it was very clear who on the project had responsibility for the tool or biophysical science development and who had more responsibility attached to actually linking science to decisions.

With regard to choosing two people from the target user audience, the initial research proposals were used so that I could suggest some names to the project investigators. In communicating with the project investigators, I often asked, "Of the following users, please name two who you would especially want to actually use and be satisfied with this tool given that you want this tool to have maximum benefit on coastal resources."

Data Collection and Analysis Interviews were conducted using a semi-structured format so that I could follow-up or ask unscripted questions when it seemed required for understanding the phenomenon of interest. Table 11 below shows the questions that were analyzed for this study.

All interviews were conducted over the phone. Interviews were recorded using Garage Band software on a MacBook Pro computer. These electronic files were then exported to NVIVO 9.0, a qualitative research analysis software package that facilitates the organization and analysis of qualitative data. This process is often referred to as "coding," which simply refers to the placing of parts of the interview (e.g., sentences, paragraphs, etc.) into labeled categories in terms of how they relate to the phenomenon of interest.

For this study, I used the research and interview questions to create a framework to hold the specific categories. These "parent categories" consisted of: "extent of linkage," "funder actions that increase linkage," and "funder actions within user engagement." Within these parent categories, specific categories were created as they

Table 11: Questions asked of project investigators and intended users.

Interview Questionnaire
1. When you think about the way science is currently conducted in comparison with how it's been conducted in the past couple of decades, do you see any significant trends? (Reminder: I am particularly interested in science that has been done with the intent to inform natural resource management.)
2. In your opinion, what accounts for the difference between the past and the present, with regard to how this science is conducted? (if applicable)
3. Thinking about the future (next 10 to 20 years), do you think the trend you identified above will continue? If not, why not? If yes, why?
4. If you could prescribe changes to how science is conducted in order to maximize the extent to which scientific information is generated and used for natural resource management, what steps would you prescribe?
5. To what extent were the implementers of the research and the intended users of the research both involved in the following four steps? Framing of the problem; Design of the research approach; Implementation of the research; Linking of research results to management decisions.
6. Do you think interactions between investigators and intended users were beneficial to the goals of the project? How could they have been more beneficial?
7. Were there any negative or challenging aspects to the interactions between project investigators and intended users?
8. As far as you know, has this project influenced natural resource management decision making? (We understand that this may not be a clear-cut "yes" or "no" answer. Therefore, please explain your answer with specific examples.)
9. In your opinion, will this project influence natural resource management decision making in the future? (We understand that this may not be clear-cut "yes" or "no" answer. Please explain your answer with specific examples.)
10. In your opinion, in the context of this project, what are the most important factors influencing the extent to which the research influences decisions?
11. Are there steps that the funding agency, scientists or intended users can take to increase the extent to which research influences decision making?

emerged from the data, as opposed to being pre-determined. For example, the following transcript snippet comes from one of the four case studies, in response to a question about critical factors influencing research use: "There [has to be] confidence that we've created a viable group, that there's good representation so that the things that we are talking about are inclusive and there's not some big gorilla sitting in the corner, some big issue, that's being unmet."

Since this was the first interview to be coded, few categories yet existed. Therefore, reading this snippet, I created a category under the “funder actions that increase linkage,” parent category and labelled it: “ensure that user group is appropriately diverse.” For subsequent transcripts, I could code data to this existing category or create new ones if the existing categories were inappropriate. Consistent with the grounded theory approach, creation and analysis of categories is an iterative and dynamic process as more and more data is gathered. Categories may be renamed and or divided into two if it serves to provide better explanations of the phenomenon being studied (Strauss and Corbin 1990; Charmaz 2006).

As one can imagine, many coded categories can and do arise as interviews are analyzed. How then does one decide which categories are most important? In contrast with quantitative approaches, which often involve statistical analyses, the qualitative approach seeks to focus on those explanations that 1) provide the closest fit with the data; 2) are most useful and 3) explain the most about the phenomenon (Strauss and Corbin 1990; Charmaz 2006).

Using these criteria, I often focus on those ideas that are noted by the most interviewees. Does this mean that the ideas mentioned by fewer people have less validity? I do not believe so. However, in the final analysis, funders need to target those ideas that have the highest likelihood of being relevant. Therefore, if an idea seems to be held by multiple people across multiple case studies, I assert that it may warrant more attention from funders.

<u>Caveats Related to the Methods</u> First, I acknowledge that interviewing four user representatives does not allow me to generalize findings to a population of 25 or more users that may be at a meeting. That would be a quantitative approach, seeking to statistically represent a population based on a sub-sample. In contrast, a qualitative

approach is constructed to generalize to theory, instead of a population (Yin 2003). The goal is to find a theoretical explanation that accounts for the interview feedback.

It is important to point out that the author also worked for CICEET as a program manager between the years of 2000 and 2012, helping to write the RFPs and run the review processes. Some may believe this disqualifies this research as being "subjective." However, within grounded theory as well as other policy sciences disciplines such as action research (O'Brien 1998) and natural resources policy studies (e.g., Clark 2002), the researcher can both study and be a participant in the phenomenon being studied at the same time. In grounded theory, the specialized knowledge of the researcher is referred to as "theoretical sensitivity" and this is brought to bear to improve explanations for the observed phenomena. In my case, as a program manager by profession, I have an advantage in taking various kinds of feedback and translating that feedback into options for other program managers. At the same time, I have to be transparent about my biases, which have the potential to distort the explanations.

My bias, based on experience as well as my own personal orientation towards natural and social sciences, is that many applied science funding programs under-emphasize the human dimension aspect of natural resource problems. In my view, this is mostly done due to convention and the history of science and technology policy in this country, which has put much more emphasis on generating new knowledge and much less emphasis on diffusing that knowledge (Tornatzky 1990; Ruegg and Feller 2003).

As in any scientific endeavor, researcher bias can be a threat to the internal validity of the research. Explicitly acknowledging this bias is an important part of putting my findings in a context for determining their validity. In addition, by triangulating between my observations and those of the project investigators and those of the project users, and by focusing on explanations that are consistent with all three perspectives, I hope to increase the strength of my case study findings (Yin 2003).

Finally, it must be acknowledged that the interviewees themselves have their biases. While some effort was chosen to get a diversity of biases, the population I had to choose from—the people participating as intended users—is constrained by the choices of the investigators as well as the participants themselves. Therefore, there are undoubtedly many biases that have not been included in this study.

Results

In reviewing the study results, lessons learned from each individual case study are first presented, relating results directly back to the research questions. In the last part of the results section, results from the cross case analysis will be presented, emphasizing any explanations that apply to all or multiple cases.

Case 1: Assessing Vulnerability to Sea Level Rise: Coastal New Jersey Through workshops and informal interactions, the Jacques Cousteau Reserve in New Jersey (see Figure 4 below) identified an explicit need on the behalf of local, regional and state decision makers to better understand their management options given predictions about sea level rise issues in the future. Working with researchers from Rutgers University, the Reserve designed an approach that would use a web-enabled decision support system as the core of an effort to convene, discuss and communicate about best management practices for dealing with sea level rise in different coastal contexts. Due to be complete by the fall of 2012, the project aimed to provide a suite of internet-based geospatial tools, including LiDAR-derived elevation data combined with existing infrastructure as well as a parcel-based query system to allow users to query the identify of land ownership parcels in high hazard conflict zones or retreat zones. As of July, 2012, this tool can be accessed by visiting http://slrviewer.rutgers.edu/

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (a GIS specialist), Investigator 2 (a user engagement specialist), User 1 (a state agency employee), User 2 (a local councilmember).

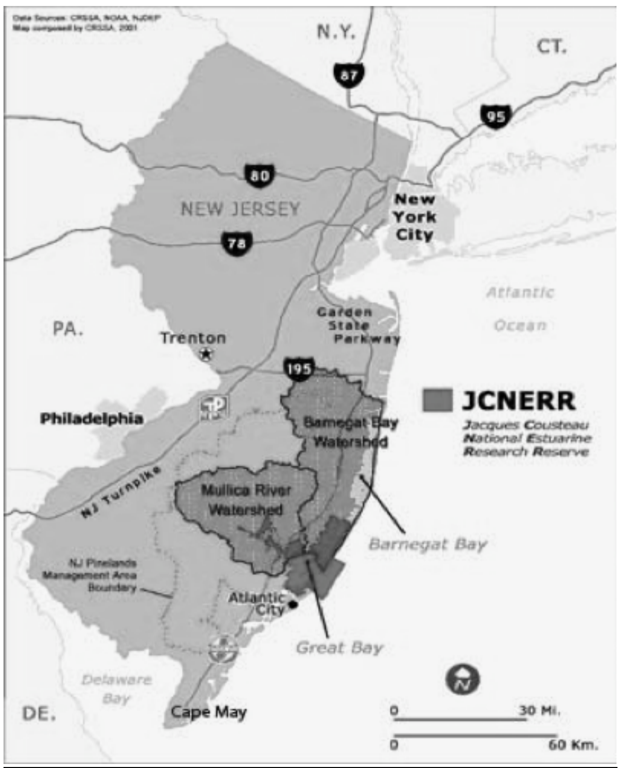

Figure 4: Map of New Jersey showing watersheds near the Jacques Cousteau National Estuarine Research Reserve.

Research Question 1: To what extent have the projects linked to decisions up to this point in time and what are the prospects for the project to link to decisions in the future? All four interviewees demonstrated a strong belief that the project was on a trajectory to link with decisions. In fact, two of the interviewees (Investigator 1 and User 2) stated that the project had already linked (see Table 12 below). This difference in opinion probably reveals a different perspective on what it means to link to decisions.

Interestingly, both of these interviewees made comments that explicitly showed that their definition was a broad one and encompassed the idea of decision makers having a changed view of reality. Achieving that changed view—to them—counted as linking to decisions. As Investigator 1 puts it: "In relation to sea level rise...the Reserve has played a key role in bringing this to the fore and so, in that respect, people are thinking about it.

Table 12: Categories relating to the three Research Questions: NJ project.

Row #	Coding Category – RQ1: Extent of Linkage	Interviewee
1	No linkage yet, but prospects are good	I2, U1
2	Project has linked to decisions	I1, U2
	Coding Category – RQ2: Funder Actions in General	
3	Ensure team defines problem thoroughly and with users	ALL
4	Require that teams communicate findings to broader user groups	I2, U1, U2
5	Involve liaisons between research and user communities	I1, I2, U1
6	Require real engagement of users throughout research process	I1, U2
7	Provide communications training for scientists	I2, U1
8	Make sure the science is highly credible	12, U1
9	Encourage a broad, long-term view of addressing the problem	I1, U2
10	Demand interdisciplinary project teams	I1
11	Provide funding for actually applying new information and tools	I1
12	Demand creativity in methods for effectively engaging busy users	I2
13	Emulate steps taken by NERRS Science Collaborative RFP	I2
14	Require that scientists participate in collaboration activities	I2
15	Require a pilot and test format so that research is iteratively improved	I2
16	Involve more young people in these projects	U2
	Coding Category – RQ3: Funder Actions: User Engagement	
17	Ensure thorough problem definition with users	All
18	Make sure there's frequent enough meetings to get needed input	All
19	Save time for hard work of understanding each other's different views	I2, U1, U2
20	After project starts, set clear goals and constraints	I1

Far right column designates which interviewees are associated with the category. I1 and I2 are investigator 1 and investigator; U1 and U2 are User 1 and User 2. Some categories may appear under both "RQ2" and "RQ3" headings. This indicates that the idea emerged both when talking about linking science to decisions generally (RQ2) , and when the interview questions forced the interviewee to talk about user engagement (RQ3).

Whether we can conclusively and concretely say that a particular resource management decision has been changed as a result? Not yet." This perspective is supported by the following statement from User 1, who noted that the research hadn't linked yet but had high potential to do so: "I was kind of shocked by the overall sea level rise inundation effects on North Jersey, which I think is something that gets overlooked in a lot of cases…so I think the tool has the potential of being a very powerful way of showing decision makers what the impacts may be in their areas and how they should allocate resources most effectively."

Research Question 2: In the case of this project, what could a funding organization have done to better link science with decisions? Of the seven categories (Rows 3 through 9, Table 12) noted by more than one interviewee, all but the one related to credibility (Row 8) involved more collaboration and communication. For example, all four interviewees focused some of their remarks on doing a better job of making sure that the problem itself receives more collaborative input from diverse participants. To this point, Investigator 2 said:"I think that first of all, it [should] be a requirement of the RFP process to somehow prove that the people who may actually use the science in an applied way were part of the proposal team that replied to the RFP. Somehow prove that, on the ground level, there were people that were part of the creation of the science model to begin with." Similarly, User 2 noted that funders must get "everyone involved working at an understandable discussion, decision and implementation level. This brings everybody onto the same page. That's probably the easiest way to put it. Once you're there, then you can move to different sections of the page but at least you're there."

Rows 4 through 6 all encourage an expansion of activities that result in greater vetting of the project approach as well as greater awareness of the project findings. More communication of findings at project's end (Row 4) and more engagement of users thoughout (Row 6) are two themes that emerged. Moreover, three of the four interviewees advocated more explicit and planned involvement of liaisons that have skill sets and responsibilities that are needed but which are not provided by scientists or decision makers (Row 5). In the case of these projects, that role was filled by the “integration lead,” which was required by the RFP. Investigator 1, the ecologist and remote sensing expert from Rutgers, noted: “Having [the Reserve be] that facilitator is a critical role because I see that as a bit different from the scientist. I think about the intermediary between the three groups, to ensure that the research is used and influences decision making.”

With regard to communication of findings, several comments point to a need for greater commitment and creativity in this area. Investigator 2 noted that users have very busy schedules so project teams need to come up with attractive ways to involve these participants. User 1 pointed out that scientists with poor communication skills often lose opportunities to connect with users:

> And the other thing that is important is that scientists have to come up with better ways to communicate the science in a way that is relatable to people who don't have a scientific background because I think that the minute you start talking in the language that scientists use, you lose a portion of the people who are ultimately going to be the decision makers that makes things happen.

Two of the interviewees (Investigator 2 and User 1; see Row 8 of Table 12) encouraged funders to stay focused on the quality of the science and the information being produced. Interestingly, even when User 1 noted the importance of credible information, it was coupled with an emphasis on making sure the science was relevant as well: “I think the science is going to have to be more targeted, more focused and more rigorous so that people understand what changes would occur, what the impacts are, and what would happen if we didn't do anything.”

<u>Research Question 3: Specifically with regard to user involvement, what can funders do to make this aspect of the project more effective?</u> When the interview was focused on user involvement issues, interviewees seemed to converge on the value and time-intensiveness of project team/user interactions (Rows 17 through 19). It was clear from the interviews that this project benefited from considerable work—which occurred

both before the project started as well as after—aimed at defining the problem and the needs. User 2 noted:

> "I know for a fact that I have been involved with Lisa's team through seminars and meetings, conferences...even through phone calls, and stopping over and talking with them. I think that led to a lot of the groundwork being set. I know I'm not the only whose been involved this way because in the webinars and different meetings, there's been a room full [of people]."

In addition, it was clear from comments that the frequent opportunities to continually refine the tool were valuable, and both investigators noted that, ideally, they would have had even more opportunities for this kind of iterative modification.

Finally, three of the four interviews made a point of remarking on the challenge of reconciling different world views: sometimes within the user group, but mostly between scientists and users. It was clear from the interviews that this challenge was something to be planned for with the knowledge that it would lead to a better result; it was not something to be avoided. User 2 said:

> "I think probably the most challenging part is the investigators themselves trying to get into the user's mind. What are they really saying? That's what I mean when I refer to 'off the wall' questions. I think we want to continue to get those; in my mind, that's not a bad thing. The challenging aspects will be getting user requests understood and incorporated."

<u>Direct Observation Notes:</u> The meeting I observed took place about 20 months into the 24-month project. It was promoted as a "kick the tires" opportunity to beta test an early version of the online tool for assessing and visualizing impacts due to sea level rise throughout Coastal New Jersey. Participants ranged from private citizens to public sector staffers from a range of scales: municipal to state to federal. The meeting involved beta testing (approximately 2 hours) and a follow-up discussion (approximately 1 hour).

Overall, I assigned the meeting a rating of "5." My observation notes of the meeting reflect many opportunities to increase the project's credibility, relevance and legitimacy. First, the meeting was very well and creatively organized in order to get maximum input from the participants; it wasn't the usual presentation followed by short "q&a." Second, a great deal of preparation when into the meeting in terms of coming up with a list of complex questions related to sea level rise and natural resources that participants had to try answer, using the beta version of the online tool. Third, the participants represented a fairly diverse cross-section of potential users. Four, the investigators received a significant amount of helpful advice and questions from the users, increasing the relevancy of the science. In addition, investigators were respectful and welcoming of the feedback, increasing the legitimacy of the work. Finally, the investigators came across as very credible resources. Many technical questions were posed by the intended users and the investigators seemed to handle them comfortably. Surveying the audience, I saw many positive and interested expressions and body language (e.g., nod of affirmation); I did not see any indications of doubt or confusion. No significant negatives were noted.

<u>Case 2: Collaborative Watershed Planning and Management: South Slough, OR</u> The South Slough sub-basin of Coos Bay, in southern Oregon (see Figure 5), faces many of the common management challenges facing coastal communities around the country: concerns regarding sea level rise, climate change, and water quality especially as it relates to finfish and shellfish populations. In addition, several proposed projects (e.g., chromite sands strip mining; expansion of local golf courses) pose questions that decision makers must struggle with. The goal of this project was to develop and test community-based collaborative methods, with the goal of improving the adaptive management of the South Slough and Coastal Frontal watersheds.

The project had four components: 1) watershed assessment/visioning; 2) watershed management (restoration, enhancement and conservation actions); 3) watershed status and trends monitoring using a set of indicators identified collaboratively with users; and 4) establishment of a Watershed Information Hub where geospatial and other data can be accessed by decision makers. These resources can be found at the web site: http://www.partnershipforcoastalwatersheds.org/

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (a monitoring specialist), Investigator 2 (a user engagement specialist), User 1 (a tribal resources administrator), User 2 (a sewer district administrator).

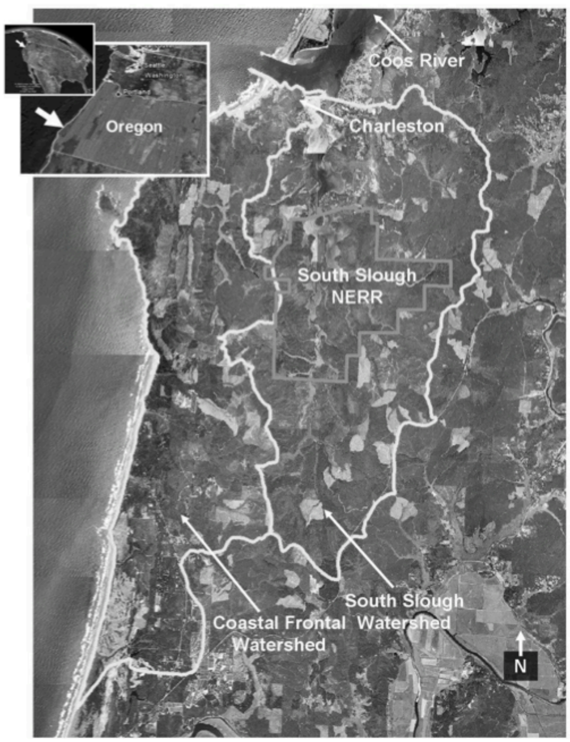

Figure 5. Map of the 14,000 hectare South Slough and Coastal Frontal Watersheds encompassed by this project.

<u>Research Question 1: To what extent have the projects linked to decisions up to this point in time and what are the prospects for the project to link to decisions in the future?</u> The four interviewees had different views on whether this project had or will ink

Table 13: Categories relating to the three Research Questions: OR project.

Row #	Coding Category – RQ1: Extent of Linkage	Interviewee
1	Project has linked to decisions	U2
2	No linkage yet, but prospects are good	I1
3	Too early to say	I2, U1
	Coding Category – RQ2: Funder Actions in General	
4	Ensure team defines problem thoroughly and with users	ALL
5	Require that teams communicate findings to broader user groups	ALL
6	Ensure engagement process has clear structure and milestones	ALL
7	Require real engagement of users throughout research process	I2, U1, U2
8	Demand creativity in methods for effectively engaging busy users	I2, U1, U2
9	Demand interdisciplinary project teams	I2, U1
10	Ensure that user group is appropriately diverse	I1, U1
11	Provide communications training for scientists	I1, U1
12	Emulate CICEET & NERRS Science Collaborative steps and RFPs	I1
13	Funders need to evaluate their own strategies and goals	I1
14	Require that scientists participate in collaboration activities	I1
15	Make sure the science is highly credible	I1
16	Involve more young people in these projects	I2
17	Encourage a broad, long-term view of addressing the problem	I2
18	Encourage methods for emphasizing positive in collaborations	I2
19	Funder for longer periods	I2
20	Require that team plan explicitly to increase and nurture trust	I2
21	Require that team plan explicitly to address politics of problem	I2
22	Question conventional wisdom re how science links to decisions	U1
23	Encourage project team to use trusted local as project spokesperson	U1
	Coding Category – RQ3: Funder Actions: User Engagement	
24	Participatory processes are very challenging, so design them carefully	ALL
25	Ensure team defines problem thoroughly and with users	I1, U1, U2
26	Ensure engagement process has clear structure and milestones	I1, I2, U1
27	Reserve time and interventions for dealing with diverse perspectives	U1, U2
28	After project starts, set clear goals and constraints	I2, U1
29	Funders should provide support for problem framing	I1
30	Encourage project team to use trusted local as project spokesperson	I1
31	Carefully prepare scientists giving presentations	I2
32	Encourage a broad, long-term view of addressing the problem	I2
33	Design process to deal with intermittent and changing attendance	U1
34	Ensure that user group is appropriately diverse	U2
35	Require that teams communicate findings to broader user groups	U2

Far right column designates which interviewees are associated with the category. I1 and I2 are investigator 1 and investigator; U1 and U2 are User 1 and User 2. Some categories may appear under both "RQ2" and "RQ3" headings. This indicates that the idea emerged both when talking about linking science to decisions generally (RQ2) , and when the interview questions forced the interviewee to talk about user engagement (RQ3).

to decisions (see Table 13 above). User 2 states conclusively that the project has already impacted decisions by increasing awareness about current conditions and changing the way people think about future threats. "According to the research that the South Slough has given us, and the anticipated ocean rise, in 10 to 12 years, this property [where I work] is going to be underwater. And I have already put the process of acquiring another piece of property in lieu of this as a possibility that we might have to address."

In contrast, User 1 and Investigator 2 could only say that the two years of funding may have laid the groundwork for future linking of science to decisions. At the time of the interview, however, with the project only three quarters complete, both felt it was too early to predict how the science would link to decisions. Investigator 1 was slightly more optimistic, predicting that the project would indeed link to decisions, but that more time was necessary to see the evidence of that linkage. Investigator 1 noted that the Coos Watershed Association, a partner non-profit organization, has plans to conduct outreach and monitoring related to project progress; these pending activities add promise that the project will link to decisions.

<u>Research Question 2: In the case of this project, what could a funding organization have done to better link science with decisions?</u> Of the eight categories (Rows 4 through 11, Table 13) noted by more than one interviewee, five of them concerned user engagement and two of them concerned communication of findings. Row 9 shows that two of the interviewees thought that funders need to make sure project teams were more interdisciplinary. As in the previous project, the issue of more thoroughly defining the problem emerged as salient. All four interviewees also converged on the importance of doing a better job of communicating findings to broader audiences.

It is important to point out that the comments regarding communication articulate a shared sense that communication is not necessarily easy to do, even with more resources; it requires strategic thinking. Investigator 1 noted:"[An important] factor is the way in which we will present and articulate the outcomes in the report. Is it going to be accessible? Can you walk up to that report and get something out of it, or is it some kind of opaque thing that doesn't do a good job at communicating. And likewise with our web sites and our presentations." User 1 said that the project's success will depend on:

> …if the project can resonate with the local audience and that's the burden of the project and its participants to find out who their audience is that they're doing all this good work for. If there's a larger community that's going to benefit from this, how does that community get communicated with, whether it's a business owner or a school teacher, and how then is that work being projected so that there's some value that will seem to accrue to the community for that effort?

Both Investigator 1 and User 1 also urged funders to think more broadly and strategically about the skills of scientists to communicate effectively. User 1 noted:

> I think, though, that sometimes what happens is that we're not as careful as we need to be about who the participants are. Sometimes are choices, while they might bring great technical expertise, these are people who are poor communicators. Or they just bring with them a certain amount of elitism because of their special expertise that, while it's valuable for the success of the project, we don't need to hear about it. We need to use it.

Finally, in contrast with the previous project, all four interviewees noted the importance of creating a very clear and structured process for engaging users and using their input (Row 6, Table 13). Investigator 1's quotation below expresses the diversity of opinion about the engagement process of this project.

> In general, we get complaints during the meetings and we get some grousing but when we do the evaluations, there's a lot more optimism about what we're doing than I would have thought. There's still people who are writing things down like, 'When are we going to get to action? We've met six times...why are we only talking?'

<u>Research Question 3: Specifically with regard to user involvement, what can funders do to make this aspect of the project more effective?</u> All four interviewees mentioned that this process entailed controversy and frustration, leading to the category described in Row 24: "participatory processes are very challenging, so design them

carefully.” While User 2 cast this controversy in a more positive light, the other three interviewees expressed more concern and ambiguity about whether the approach was optimal and what could be done about it. For example, Investigator 2 notes: “It's been a bit arduous; we've sensed some frustration from our committee about the slowness of our process and that we've been focused on process rather than rolling up our sleeves and getting down to actions.” Moreover, both investigators characterized the frustration as being expressed by more than just a small minority of participants.

The experience of User 1 can be illustrative here. User 1 eventually recused himself from the project meetings because he did not want his frustration to detract from the experience of others; in other words, he did not feel that he could continue participating in a productive fashion. User 1’s comments underscore the challenge of implementing a participatory process for the problem framing stage of a research project, especially with diverse opinions and inconsistent attendance by participants (see Rows 27 and 33).

> We did a lot of discussion about trying to frame the problem, but I don't think we ever arrived at a problem. I think we arrived at a suite of problems and we spent a whole lot of time trying to prioritize them. When you have a committee of many people and every time you meet, there's a different combination of 30 that show up, it's difficult to get to a priority, because you're always revisiting what you talked about before. So, in terms of framing the problem, I don't think we were successful.

This project experience illustrates that, sometimes, interactions between scientists and a diversity of users can be very difficult to manage. Interestingly, this project did receive some input and support from a professional with considerable experience in participatory processes around complex resource management problems. Yet the frustrations still emerged in spite of this additional support, suggesting that funders may need to think more critically about how expertise is integrated into a project.

Direct Observation Notes: The meeting I observed took place approximately 15 months into the 24-month project. It was focused on transitioning from a focus on process to a focus on determining the key issues—given the broad parameters orginally noted in the awarded proposal—that stakeholders want to focus on. The meeting was four hours long and was divided equally between technical presentations, large group discussions about issues and breakout group discussions about barriers and opportunities.

Overall, I assigned the meeting a rating of "3." My observation notes reflect potential increases and decreases to credibility, relevance and legitimacy. On the plus side, I noted several factors: 1) despite the fact that this group had met several times before and had meetings scheduled relatively frequently (i.e., every couple of months), there was still a relatively large group of people present: approximately 30 people. In addition, the group was relatively diverse, having representatives from environmental advocacy groups, state agencies, citizen's groups as well as industry (e.g., tourism, lumber, and mining); 2) organizers demonstrated a clear commitment to legitimacy (Cash et al 2003).

On the negative side, the meeting could have been better facilitated. Despite the presence of several people with facilitation training, it did not seem to be clear which facilitator was playing which role. This led to an inconsistent day; sometimes the meeting proceeded smoothly and other times discussions were less productive. For example, during a presentation on ecosystem condition by a biophysical scientist, the decision was made to truncate the talk as the discussion began to get heated and meeting organizers did not think it was proceeding in a productive direction. In my opinion, this interaction could very well have decreased credibility and legitimacy. This incident could have been avoided with more preparation between the facilitators and the invited speaker.

Finally, my direct observation notes indicate that I had trouble understanding how this meeting as a whole, as well as the different components of the meeting, fit into a larger process. This could be due, of course, to the fact that I had missed the previous meetings and was only getting a "snapshot" of the process. However, my confusion was somewhat corroborated by interviewee feedback noting that a clearer process would have been helpful (see Table 13).

Case 3: Paleoecology and Geospatial Models for Salt Marsh Management: Watsonville, CA The Elkhorn Slough Reserve, located in Watsonville, CA, near Monterey (see Figure 6, below), is home to several thousand acres of salt marsh. Managers of these and surrounding habitats are concerned about the future of these marshes given sea level rise predictions as well as sedimentation changes—for example, due to upstream dams. Undoubtedly, change is coming, but decision makers are unsure of what baseline they should use to set habitat objectives. In some cases, the current extent of salt marshes is a relatively recent (past several centuries) phenomenon, due to land use changes such as forest clearing and agriculture. Therefore, to manage for the future, decision makers can benefit both from predictive models looking forward but also studies of changes that occurred in the past. These two tools can combine to help managers understand which existing marshes would benefit most from conservation and enhancement strategies.

The goals of this project were to produce predictive decision support models based on high resolution, LiDAR-derived topography, terrestrial laser scanning and sediment budget assessments. Simultaneously, investigators aimed to better understand historical sedimentation trends using shallow reflection seismology and ground penetrating radar. As tools were produced, they were shared and refined with decision makers on the Tidal Wetland Project team, an ongoing ecosystem-based management initiative. The products developed by this project can be found at the following web site: http://www.elkhornslough.org/research/conserv_marsh.htm

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (an ecologist), Investigator 2 (a user engagement specialist), User 1 (a wetlands manager), User 2 (a federal agency representative).

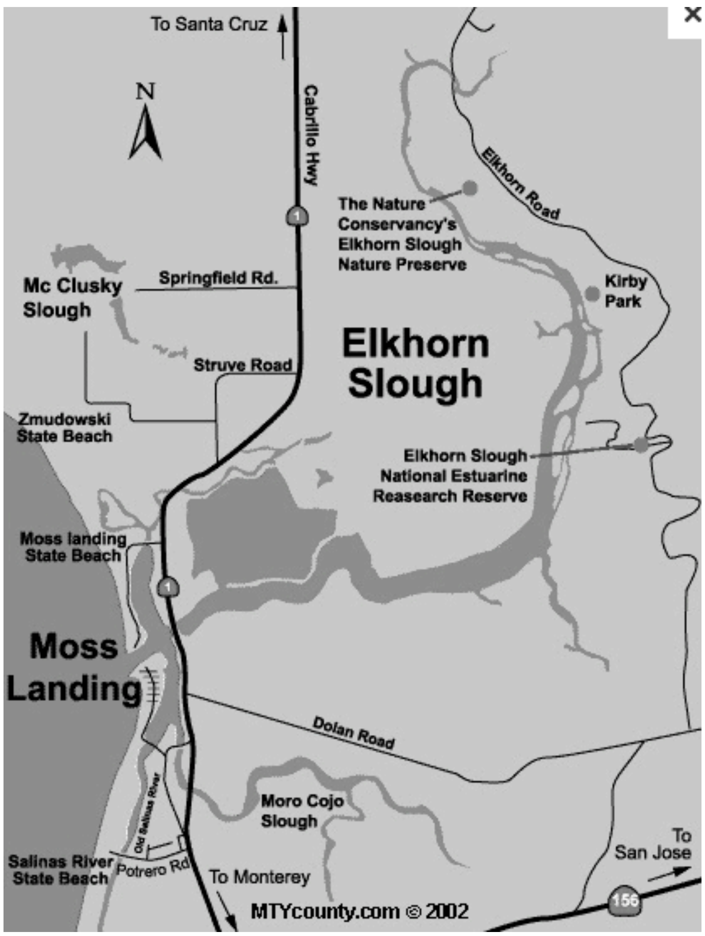

Figure 6: Map showing Elkhorn Slough and the location of the Elkhorn Slough Reserve.

<u>Research Question 1: To what extent have the projects linked to decisions up to this point in time and what are the prospects for the project to link to decisions in the future?</u> All four interviewees stated conclusively that this project had already linked to decisions and would continue to set the foundation for decisions in the near future (see

Table 14: Categories relating to the three Research Questions: CA project.

Row #	Coding Category – RQ1: Extent of Linkage	Interviewee
1	Project has linked to decisions	ALL
	Coding Category – RQ2: Funder Actions in General	
2	Ensure team defines problem thoroughly and with users	ALL
3	Ensure engagement process has clear structure and milestones	ALL
4	Require real engagement of users throughout research process	I2, U1, U2
5	Demand creativity in methods for effectively engaging busy users	I1, U2
6	Require that teams communicate findings to broader user groups	I1, U1
7	Require a pilot and test format so that research is iteratively improved	I1, I2
8	Think explicitly about the issue of trust	I1, U2
9	Demand interdisciplinary project teams	I1
10	Funders need to evaluate their own strategies and goals	I1
11	Make sure the science is highly credible	I1
12	Provide guidance to project re implementing collaborative science	I1
13	Make project teams strictly accountable for user engagement	I2
14	Increase incentives for scientists to engage in collaborative science	U1
	Coding Category – RQ3: Funder Actions: User Engagement	
15	Ensure engagement process has clear structure and milestones	ALL
16	Ensure team defines problem thoroughly and with users	ALL
17	Make sure there's frequent enough meetings to get needed input	I2, U1, U2
18	Remain flexible to changing needs as project progresses	I2, U1, U2
19	Save time for hard work of understanding each other's different views	I2, U1
20	Increase incentives for scientists to engage in collaborative science	I2, U1
21	Provide support specifically for problem framing	I1
22	Involve liaisons between researchers and users	I2
23	Require real engagement of users throughout research process	I2
24	Provide time for users to confirm credibility of science	U1
25	Require a pilot and test format so that research is iteratively improved	U1
26	Participatory processes are very challenging, so design them carefully	U2

Far right column designates which interviewees are associated with the category. I1 and I2 are investigator 1 and investigator; U1 and U2 are User 1 and User 2. Some categories may appear under both "RQ2" and "RQ3" headings. This indicates that the idea emerged both when talking about linking science to decisions generally (RQ2) , and when the interview questions forced the interviewee to talk about user engagement (RQ3).

Table 14 above). Of the four case studies, this was the only project with a unanimous appraisal pointing to clear linkage between the project and decisions, even though the project wasn't complete.

The interviewees agreed that the assumption held by most resource managers in the area was that the decrease in marsh extent over the last 60 years—from approximately 2,000 acres of marsh to 800 acres—was an aberration that needed to be combated. The paleoecology project indicated that if one goes back far enough in the sediment record, the marsh probably only covered about 800 acres. Revealing this case of shifting baselines has, all four interviewees agreed, changed the way decision makers perceive the problem of marsh loss and how to proceed. User 1 noted: "At the end of the day, does it fundamentally change the goal of preserving tidal marsh? I'm not sure. But there's no doubt that it provides a very healthy perspective of the big picture on resolving those questions." Investigator 1 probably gave the project the least confident appraisal, noting that it could have linked to a greater extent if some modifications had been made to the process. "The data will certainly shape management, but if we had more carefully designed a really robust process, with more clarity about what exactly we would do with different scientific outcomes, we would have more efficiently and rapidly incorporated the new information."

Research Question 2: In the case of this project, what could a funding organization have done to better link science with decisions? All seven categories (Rows 2 through 8, Table 14) noted by more than one interviewee were directly related to the user involvement aspect of the project. All four interviewees focused on defining the problem thoroughly with users (Rows 2). Also, there was broad agreement that this was especially important early on in the process as assumptions about problems and potential solutions are being vetted and settled. User 1 said:

> By doing [collaborative problem framing] in advance, my sense is that it will help assure that the science is tightly focused around the most pressing management needs and it would also help ensure that the participants in the planning process have their specific questions addressed in a way this is satisfactory to them and in a way that they can buy into the results and share in the learning process.

After ensuring that problem framing happens early, thoroughly and collaboratively, funders should ensure that there is a clear and transparent process for engaging users and incorporating input into the project (Row 2). Investigator 1 notes: "There needs to have been a lot of early work before the science was ever done to reach agreement on what sort of new information would actually be used to change management, and even to consider potential scenarios for scientific results and management outcomes."

Yet despite good planning, interview data suggests, there is likely to still be a mismatch between user expectations and what scientists produce. Therefore, both investigators encouraged funders to advocate for a "pilot and test" format to research projects, even those with timespans as short as two years (Row 7). Investigator 2 noted:

> There would be a two-step process; someone would do a pilot research project that doesn't require a lot of resources and then come back to those natural resource managers and say, 'Is this what you were thinking about because this is what we're seeing.' And I think at that point, natural resource managers often then say, 'Oh, well that's not really what we meant.'

If the above mismatch is not planned for, it is obvious that it could result in a significant waste of resources.

<u>Research Question 3: Specifically with regard to user involvement, what can funders do to make this aspect of the project more effective?</u> When asked specifically about user engagement processes, interviewees focused on problem definition and providing a clear structure for user engagement (Rows 15 and 16). Rows 17 through 19 highlight the related issue of building enough time and appropriate processes to allow project progress to be carefully considered by users and—if necessary—to be modified by those users (Row 18). Although all four interviewees indicated that the proposal had linked to decisions, three of the four interviewees (everyone except User 2) suggested that the project could have easily been improved with a process that was better planned and more flexible. Investigator 2 noted:

> I think [investigator-user interactions] could have been more beneficial if the overall framework for taking the information to decisions was clear to everybody and therefore the key users could have seen where they were in the process and how important it was that they engaged at that point in time. We saw some absenteeism by people, a smaller group towards the end. Even project

> investigators might have been less enthusiastic there at the end. If there had been a clear decision framework it would have helped people stay engaged.

With regard to flexibility, User 1 noted that "there was a review process and the intended users were invited to comment on the implementation of the research." However, User 1 also said that: "The degree of flexibility was quite small; there weren't a lot of choices or wiggle room or opportunity for influence." Investigator 2 noted: "There was, I think, varying levels of interest in and ability to be flexible with the project. So, some of [the scientists] said, 'This is what I said I was going to do so that's all I'm going to do' and others were like, 'Hey, we really like this interactive back and forth and I want to remain as flexible as possible.'"

Finally, Investigator 2 and User 1 remarked on a challenge that emerged in both the previous cases as well: that is the different expectations and interests of scientists versus users. For funders, this has implications for how and when they distribute funds in order to make sure that the problem definition has been properly vetted with users. Otherwise, if the proposal is funded without due consideration of a diverse set of views on the problem, it can be too late to adjust course. User 1 describes it this way:

> One of the problems I think with the way science and management interact is that by the time you have a scientist working on your project, if they're a research scientists hoping to publish in a peer reviewed journal, typically the degree of specialization of their toolkit is really tight. So, by the time you have an individual working on your project, the range of things they can look at to inform you about your management question is very small. This is not reflective of any flaws in the great work that was done at our site; but it just points out that management questions are typically broad and research questions are typically very, very narrow.

<u>Direct Observation Notes:</u> The meeting I observed took place approximately 19 months into a 24-month project. It was focused on describing the significant progress and data collected with regard to both of the project's components: 1) the paleoecology work to establish more accurate historical baselines of marsh extent; and 2) the

modeling and visualization of sea level rise scenarios. In addition, the agenda allowed time for investigators and intended users to discuss management implications. The meeting was approximately four hours long.

Overall, I assigned the meeting a rating of “4.” My observation notes reflect mostly positive comments with many opportunities to increase credibility, relevance and legitimacy. As I will discuss, however, there were aspects of the meeting that could have been improved. On the plus side, I noted several factors: 1) the meeting was extremely well organized and it was obvious to everyone involved that the team had spent a great deal of time preparing and thinking about how to best use the four hours allocated to the event; 2) the facilitation was excellent; the facilitator was exteremely diligent and effective in making sure that everyone obtained equal opportunity to contribute, increasing legitimacy. The meeting was well structured to give intended users ample time to talk and the facilitator was good about not letting presenters use more than their alotted time; 3) the technical presentations were mostly effective and the presenters were mostly very receptive to comments, creating many opportunities for increases in scientific credibility, relevance and legitimacy.

The main negative for the meeting was the relatively small number of intended users (approximately 12) as well as the low diversity of intended users. For example, there were no representatives of the agricultural community surrounding the Reserve, even though the influence of the agricultural activities on the salt marsh habitats—as well as any future management scenarios—is quite significant. In follow up conversations with project investigators, it became clear that the diversity of users at this particular meeting was fairly typical for the preceding meetings as well. However, in future meetings, investigators hoped to expand and broaden the list of participants.

Case 4: Assessing Risk of 100-Year Floods: Lamprey River Watershed, NH Like many other coastal areas, coastal New Hampshire is confronting the effects of rapid development and associated land use change, while also dealing with the serious impacts of a changing climate. Decision makers in this area require local-scale scientific information regarding flood risk in the context of climate change, but this information is lacking. The goal of this project is to develop and refine a method for assessing flood risk and demonstrate the method for the Lamprey River watershed of Great Bay, NH (see Figure 7, below).

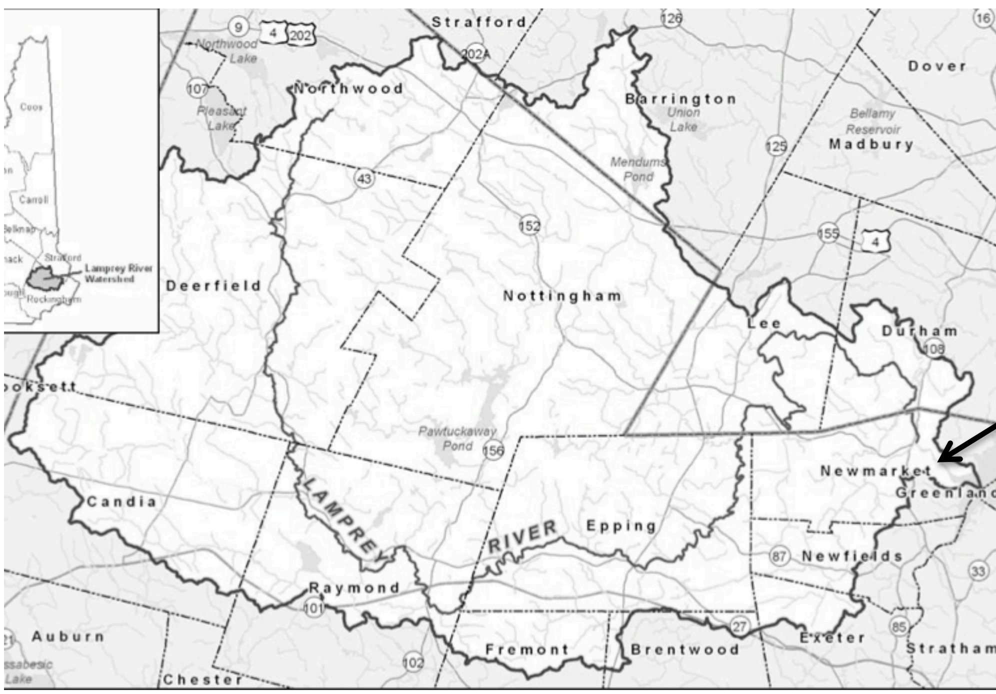

Figure 7: Map of the Lamprey River Watershed. The watershed touches the boundary of the Great Bay Reserve near the black arrow on the right of the image.

The framework of the approach involves examining the impacts of climate change on rainfall depths and floodplain elevations under several different scenarios, including recent history (1981 to 2001) as well as three different future climate change scenarios. These projections were then mapped to four land use scenarios with a range of impervious cover (e.g., maximum build out; a low impact development scenario, etc.).

Table 15: Categories relating to the three Research Questions: NH project.

Row #	Coding Category – RQ1: Extent of Linkage	Interviewee
1	Project has linked to decisions	I2
2	No linkage yet, but prospects are good	U1
3	It is too early to say	I1, U2
	Coding Category – RQ2: Funder Actions in General	
3	Ensure team defines problem thoroughly and with users	I1, I2, U1
4	Think explicitly about the issue of trust	I1, I2, U1
5	Make sure the science is highly credible	I1, U1, U2
6	Require a pilot and test format so that research is iteratively improved	I1, I2
7	Make project teams strictly accountable for user engagement	I1, I2
8	Demand interdisciplinary project teams	I2, U1
9	Question conventional wisdom re how science links to decisions	I1, U2
10	Demand creativity in methods for effectively engaging busy users	I1
11	Increase incentives for scientists to engage in collaborative science	I1
12	Ensure that enough funding is allocated to user engagement activities	I2
13	Emulate steps taken by NERRS Science Collaborative RFP	I2
14	Involve liaisons between research and user communities	I2
15	Require that teams communicate findings to broader user groups	I2
16	Require real engagement of users throughout research process	I2
17	Encourage methods for emphasizing positive in collaborations	U1
18	Provide funding for actually applying new information and tools	U1
19	Require that team plan explicitly to address politics of problem	U2
	Coding Category – RQ3: Funder Actions: User Engagement	
20	Ensure team defines problem thoroughly and with users	ALL
21	Require a pilot and test format so that research is iteratively improved	I1, I2, U2
22	Participatory processes are very challenging, so design them carefully	I1, U1
23	Ensure that user group is appropriately diverse	U1, U2
24	Make sure there's frequent enough meetings to get needed input	I2, U1
25	Save time for hard work of understanding each other's different views	I1, I2
26	Think explicitly about the issue of trust	I1, U1
16	After project starts, set clear goals and constraints	I1
27	Provide communications training for scientists	I1
28	Provide guidance to project re implementing collaborative science	I1
29	Question conventional wisdom re how science links to decisions	I1
30	Ensure that enough funding is allocated to user engagement activities	I2
31	Design process to deal with intermittent and changing attendance	U1
32	Require real engagement of users throughout research process	U1

Far right column designates which interviewees are associated with the category. I1 and I2 are investigator 1 and investigator; U1 and U2 are User 1 and User 2. Some categories may appear under both "RQ2" and "RQ3" headings. This indicates that the idea emerged both when talking about linking science to decisions generally (RQ2) , and when the interview questions forced the interviewee to talk about user engagement (RQ3).

Finally, these products were vetted with local decision makers through a series of focus groups. Due to a six-month delay in acquiring necessary LiDAR data, this project was not as far along as the other projects in this study. Nevertheless, a suite of products are available at the following web site: http://100yearfloods.org

The synopsis that follows refers to interviews with four people associated with the project: Investigator 1 (a biophysical scientist), Investigator 2 (a user engagement specialist), User 1 (a local public works director), User 2 (a local city planner).

Research Question 1: To what extent have the projects linked to decisions up to this point in time and what are the prospects for the project to link to decisions in the future? Three of the interviewees noted that it was too early to tell if this work had linked to decisions (see Table 15 above), with two of the respondents evincing more confidence than the third that the project was on a trajectory toward linking to decisions. Finally, one of the interviewees felt that this project had already begun to link to decisions. As noted earlier, this difference of opinion may be the result of different conceptions of what it means to link to decisions. In the quotation below, Investigator 2 clearly indicates that his conception of "linking to decisions" refers to evidence that the science has changed the way someone perceives an issue, such that the person could act differently as a result.

> What I've seen in the thinking of some of the advisory board members who are also stakeholders and users was 'Oh my god. We're clearly undersizing the floodplain. We need to be thinking about this as a much bigger area. We need to look at these areas that are flooded, will be flooded more and more in the future, because we're going to have to figure out a way to protect the municipality and protect the homeowner.'

User 1 thought that the linkage hadn't happened yet but clearly thought it was just a matter of time.

> Some of the community regulations are going to require review with [the project] overlay maps. So when planners and engineers sit down and discuss what should be done on a project or at a given site, they're going to make different decisions and that's why it would have an impact on flooding and potential problem areas in the future. It certainly should reduce exposure and damages and some environmental impacts.

In contrast, Investigator 1 struck a more cautious assessment of how the science would be used.

> My hope is that planners and resource managers will start considering the isse of changes in both the frequency and the extent of the 100-year flood, but also having more frequent floods as well, in the decisions we make, whether they're around land use, zoning, riparian rights, fisheries, sediment loads, etc. My big hope is that FEMA will begin--they're already revising their maps--but hopefully they will also begin to at least acknowledge that there's some model output for the future that might be useful for to resource managers.

User 2's response was the least assertive : "I don't know. I have higher hopes than usual because this issue touches everyone around here, and it touches their wallets." This comment hints at some of the sociological considerations at play for this particular project.

Finally, it is also possible that the lack of confidence in terms of this project linking to decisions could be attributed to this project's relative lack of maturity, due to the LIDAR data being delayed.

<u>Research Question 2: In the case of this project, what can funding organizations do to better link science with decisions?</u> Of the seven categories that were noted by multiple interviewees (see Rows 3 through 9, Table 15), six of the categories were directly connected to user engagement and the human dimension aspect of the problem. One category (Row 5) focused on the importance of producing credible science; this idea was mentioned by three of the four interviewers. Interestingly, in all three instances that credibility was mentioned as being important, the interviewee was making the point that the user engagement shouldn't replace credibility; rather, issues related to relevance and legitimacy (Cash 2003) should be increased to a level that was comparable with credibility. For example, Investigator 1 said: "The science needs to be credible to the user. In some ways, I think there may be a higher bar than being credible

for a publication in that it needs to pass peer review scientific method process, but it also needs to pass [as] useful information."

Based on the interviews, the primary way that a funder could have improved this project would have been to focus more on increasing the relevancy of the work through more extensive collaborative problem definition with users (Row 4). Investigator 2 noted:

> The research has to be relevant to the issues that the decision makers are faced with. That's really the place to start. Clearly, the problem was important to the users and it was something they were currently dealing with and knew were going to become even bigger issues in the future and they were going to have to deal with them. So, the relevancy is the key thing.

Along similar lines, User 1 said: "I think how we frame questions, and how we decide what are the issues that need to be investigated to be able to answer...that's where I think a real focus and energy has to be put."

This project provides an excellent illustration of the idea embodied in Row 6: that of structuring the project in a pilot and test format. Despite efforts to collaboratively define the problem, the team came to the realization six months into the project that a key aspect of the inquiry was missing. This realization only came about as the meeting participants began connecting the dots between the data they were collecting and how the data would eventually link to decisions. Investigator 1 explains it this way:

> I thought of this as a one-way problem, initially, but coming back to it...it was really our advisory committee that said that drawing these hundred-year floodplain maps for current conditions and future conditions are really interesting, but are municipalities going to be legally able to use these? So, that actually became a whole additional layer that we added to our project and we went out and found the money to do that.

Row 7 in Table 15 notes a convergence between both the investigators around an idea critical for funders to think about; user engagement will not happen unless the funders insist on it and insist that user engagement receives enough specific funding so that it can done thoroughly. Investigator 2 said: "If it's not a requirement of the funding, it may or may not happen to the extent or clearly defined enough to really be effective." Investigator 2 commented on the unique role of funders as being able to change the academic culture: "We need continued pressure from the federal funding agencies. They don't move quickly, but they can move us substantially, and I think that they can change behavior much more rapidly than, say, universities can."

It is interesting to note that three of the four interviewees explicitly called out the importance of trust and relationships in the context of this project. Investigator 1 notes:

> If [a particular user on the project] was working with a scientist that he did not know and who might have different motives or was way more focused on getting a publication as opposed to solving an external problem, I don't think the result would be as valuable or as widely used. This is true for politicians, resource managers...I think it's true for scientists. We have our credibility, but if that credibility is only in the scientific community, it's really not as potentially valuable for local and regional decision making.

Somewhat related to the issue of trust, User 2 focused most of her comments on the importance of partisan politics as a barrier to linking science with decisions, especially for a project that plays out in the context of climate change research, already quite controversial. User 2 said:

> What I see particularly in New Hampshire…people in appointed and elected positions at every level seem to be able to just say 'OK, so that's the science but here's the reality. Here's our financial reality; here's our political reality, and this is what we're going to do.' And it seems to be able to be done readily, and there doesn't seem to be a consequence for setting aside of the science. I think there needs to be a different way to message, because this message isn't working.

The reader will note the phrase "financial reality" in the above quotation; the emphasis on financial forcing factors also emerged as a critical concern to this user. Asked what factor was most critical in determining whether the research would link to decisions, User 2 promptly responded: "How we come out of this economic recession."

<u>Research Question 3: Specifically with regard to user involvement, what can funders do to make this aspect of the project more effective?</u> When asked to talk

specifically about user engagement issues, the interviewees echoed many of the themes that have already been reported. For example, Rows 20 and 21 are the same as Rows 3 and 6 in Table 14. Also, Row 26, dealing with trust, has already been discussed.

A theme that emerges from these questions relates to Rows 22 through 24 as well as Row 28: namely, participatory processes are difficult and they require careful planning and time and money. Investigator 2 noted: “The users don't really get the time they deserve within the project. So, time is always the limiting factor. This type of approach does take more time, but I think it needs dedicated time and resources to ensure that the users and investigators actually get a chance to work together more frequently.” Investigator 1, on the other hand, focused on the fact that very few scientists understand how to do this kind of work.

> Scientists are just not trained to work with a bunch of people who are not scientists and so this is something that's really new for us. There's nothing like experience to show you how you fail. So, the time to actually do it is important, but I also think that really looking inward for scientists in both communicating with people who are non-scientists, working with people who are non-scientists, running meetings, understanding how organizations work…that would be really beneficial to scientists.

The focus on experiential learning was corroborated by comments from Investigator 2 and User 1. Investigator 2 noted that some of the researchers had their doubts about working with users so closely, but they realized the benefit of these interactions as the project progressed. User 2 noted:

> I would say that my personal exposure in this has been eye opening. I was very impressed with this approach and had never been involved with one of these collaborative type research programs before, and I was really impressed with the overall organization and the efforts that were extended to try and gain that insight from the end users.

User 1 also focused on an issue that one of the users from the Oregon project also emphasized; it’s difficult to manage these collaborative projects (Row 22) with diverse perspectives, especially when many of the users are very busy and may not even remember the gist of the research from one meeting to another. User 1 thought that more frequent meetings were warranted.

User 2 focused on the “preaching to the choir” aspect of the meetings and encouraged the project team to be more purposeful in getting a broad diversity of users to the meetings (Row 23):

> I really wish that I didn't have to tell this story about the people in our region that have contrary views, strongly held contrary views. I wish they were there. I think that's what would make this much more lively because on a day to day basis, those people are impacting our organization. So, I think there needs to be more of that reality. I should have been encouraged to not be there myself but to have somebody there who totally doesn't believe [that climate change is occurring.]

Direct Observation Notes: The meeting I observed took place about 15 months into a 24-month project. It was focused on downscaling global climate data, buildout scenarios as well as research on the legal implications of new floodplain maps. The meeting was approximately three hours long.

Overall, I assigned the meeting a rating of “3.” My direct observation notes reflect that the meeting created some opportunities for increased credibility, relevance and legitimacy, and there were no outstanding problems. On the other, as is discussed below, the meeting seemed to fall well short of its potential with regard to increasing relevance and legitimacy. On the plus side, I noted several factors: 1) all of the biophysical science presentations were effective; that is, they were appropriate to the audience and not overly long; 2) The team expressed explicit interest in the viewpoints of the intended users and seemed to sincerely care what the users thought. 3) Some of the intended users, though not many, made suggestions about how to make the research more relevant or useful and the investigators seemed to hear the suggestions and capture them.

On the negative side, the meeting could have been better organized to give the intended users more time to digest and react to the information as well as to motivate the intended users to think creatively and contribute to the discussion. Instead, the meeting was set up in the standard scientific conference format where scientists have the floor for approximately 15 minutes and then users are invited to ask questions. This format sets up a “consultative” dynamic rather than a collaborative dynamic (Barreteau 2010).

Results Across the Four Cases: Did Projects Link to Decisions? For one project (the CA case), all interviewees were in agreement that the project had already begun influencing decisions amongst intended users, even though the project wasn’t completely done yet. For all four projects, at least one of the four interviewees said that the project had already begun linking to decisions. In three of those cases, an intended user was one of the people making this statement (see Table 16 below). It was clear that there were differences in how people conceptualized the phrase “linking to decisions.” Some took a more narrow approach while others (such as User 2 for the NJ project or Investigator 2 for the NH project) thought about linking more broadly as changing the way a decision maker thinks about a problem or solution. Nevertheless, those who did claim that the project had linked to decisions mostly characterized this linkage as: increased awareness with intent to act differently in the future. Perhaps the best example comes from Investigator 2 on the NH project, who notes that he has seen advisory board members from his project, who serve on decision making organizations, citing his project as the reason for advocating a different approach to floodplain mapping and stormwater management.

Results Across the Four Cases: What Funders Should Do? Only six categories emerged from all four projects (Table 16). All but the last one—focusing on the credibility of the science—involved user engagement topics or communicating findings with users.

Table 16: Categories that occurred in at least two projects. Shading is used to highlight those categories that emerged from at least three of the four projects.

Coding Category	# of proj. (n=4)	# of people (n=16)	C1 NJ	C2 OR	C3 CA	C4 NH
RQ1: Extent of Linkage						
Project has linked	4	8	2	1	4	1
No linkage yet, but prospects are good	3	4	2	1	0	1
Too early to say	2	4	0	2	0	2
RQ2: Funder Actions						
Ensure thorough problem definition with users	4	15	4	4	4	3
Communicate effectively to broad user groups	4	10	3	4	2	1
Demand user engagement at all stages	4	9	2	3	3	1
Need creative methods 4 engaging busy users	4	7	1	3	2	1
Demand interdisciplinary project teams	4	6	1	2	1	2
Make sure the science is highly credible	4	6	2	1	1	3
Think explicitly about the issue of trust	3	6	0	1	2	3
Pilot/testing to iteratively improve the science	3	5	1	0	2	2
Emulate steps taken by CICEET/Collaborative	3	3	1	1	0	1
Engagement process must have clear structure	2	8	0	4	4	0
Involve liaisons between researchers & users	2	4	3	0	0	1
Hold projects accountable re user engagement	2	3	0	0	1	2
Question role of science in solving problems	2	3	0	1	0	2
Increase incentives for academics to engage	2	2	0	0	1	1
Emphasize positive tone in collaborations	2	2	0	1	0	1
Fund more actual application of new info/tools	2	2	1	0	0	1
Explicitly address politics of the problem	2	2	0	1	0	1
Funders evaluate their own strategies/goals	2	2	0	1	1	0
Provide communications training for scientists	2	2	1	1	0	0
Make sure scientists themselves engage users	2	2	1	1	0	0
Involve more young people in projects	2	2	1	1	0	0
Encourage long-term view of problem framing	2	2	1	1	0	0
RQ3: User Engagement Funder Actions						
Ensure thorough problem definition with users	4	15	4	3	4	4
Ensure frequent meetings to get needed input	3	9	4	0	3	2
Save time for understanding different views	3	7	3	0	2	2
Participatory processes need careful planning	3	7	0	4	1	2
After project starts, set clear proj. parameters	3	4	1	2	0	1
Engagement process must have clear structure	2	7	0	3	4	0
Pilot/testing to iteratively improve the science	2	4	0	0	1	3
Ensure user group is appropriately diverse	2	3	0	1	0	2
Provide support explicitly for problem framing	2	2	0	1	1	0
Design process for intermittent attendance	2	2	0	1	0	1
Require real user engagement at all stages	2	2	0	0	1	1

Clearly, ensuring collaborative problem framing was a dominant concern, with all but one of the 16 people interviewed mentioning this as a salient issue.

Results Across the Four Cases: What Should Funders Should Do Specific to User Engagement? When asked to focus on user engagement activities, interviewees once again emphasized the importance of collaboratively and thoroughly framing the problem with users; 15 of the 16 people interviewed emphasized problem definition in their comments (Table 16).

There were four categories that emerged in three of the projects. One category focused on having more meetings throughout the project to vet the science at different stages; another emphasized being ready and saving time within meetings to allow people the opportunity to overcome differences in world views and perceptions of the problem. Still another category emphasized the importance of setting clear parameters for the project, once the problem had been thoroughly defined. These comments accentuated the challenge and tension of being flexible and taking input, but also not losing focus on the core goals of the project. Striking this difficult balance was only one of the reasons that 7 people, across three projects, also noted that participatory processes can be very challenging and require time and resources to implement successfully.

Discussion

In seeking to understand whether a research project is linking to decisions, it is very important to establish the expectations at the outset. This research competition was created with a key general expectation. Projects should begin to link to decisions in a timely fashion: that is, one should be able to gather evidence that, during the project, intended users of the research could demonstrate enhanced awareness and understanding of the problem and potential solutions. In addition, one should see evidence of intent to use any new knowledge in the decision contexts each user faces. Intent to use knowledge implies that the users find the research credible, relevant and legitimate (Cash et al 2003). Evidence of the above would qualify as “uptake,” an explicit step on the impact pathway—uptake, outcomes, impact—described by the CGIAR Science Council (2006).

Given that these projects were not even complete when this analysis took place, a clear caveat is that changes could have happened in the final months of the project. Both increases and decreases in the extent of linkage are possible. An additional caveat is that actually tracking the impact of these projects as users employ their new knowledge in decision making contexts is beyond the scope of this analysis.

The expectation of uptake occurring during the project is key. In other words, smaller magnitude benefits occuring early in the project and soon after completion were considered more desirable than a more significant benefit that takes a decade or more to develop. This expectation with regard to timeliness has been pointed out as a clear prerequisite for sustainability science (Ziegler and Ott 2011). Sustainability science, like the science funded under the RFP studied here, is focused on creating timely knowledge to address societal problems in a way that clearly extends beyond the realm of academia or just the people conducting the science. Again, not all science needs to share these characteristics, but it is reasonable that certain issues—such as adaptation to climate change, for example—require more timely solutions than others.

Previous reports have noted that a focus on process is appropriate for climate change related problems (e.g., NRC 2009; Meyer 2011). The NRC report actually proffers as one of its primary recommendations the injunction to “focus on process over products.” Climate change, like many complicated environmental problems, are considered “wicked” (Rittel and Webber 1973) and are therefore not amenable to solutions that are divorced from human values (NRC 2009; Ziegler and Ott 2011).

Assuming that process is important, the work of Cash et al (2003) is instructive in terms of what aspects of the process seem to lead towards greater linking of science to decisions. According to William Clark of Harvard University, a co-author of this research, the Cash et al findings are based on over a decade of empirical data pointing to the key ingredient of trust. The research team then endeavored to “unpack” trust, resulting in a focus on three attributes: credibility (meeting technical standards), relevance (appropriate for the users), and legitimacy (procedurally fair). (It is important to keep in mind that the levels of these attributes are to be decided by all the participants, not just the scientists in the process.) Based on these assumptions a logic model begins to take shape (see Figure 8 below). This model is helpful in reviewing the research questions of this study and exploring what funders can do to better link science with decisions.

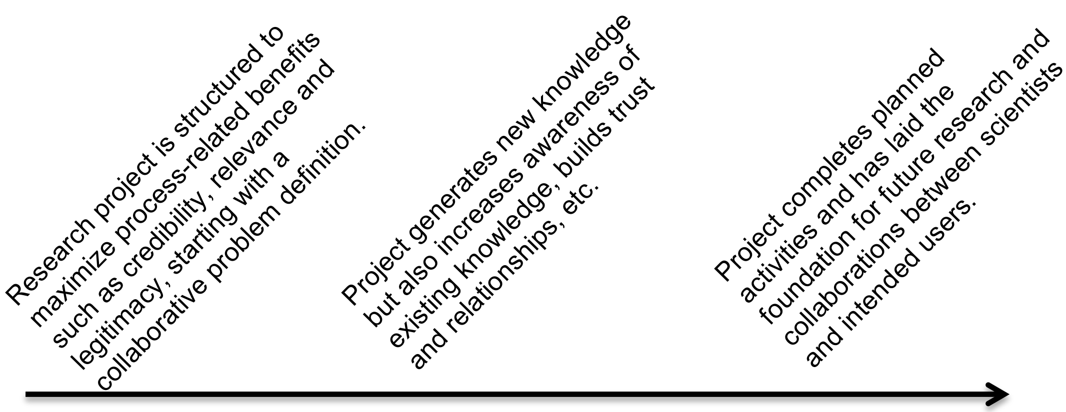

Figure 8: Simplified model representing the expectations of projects funded through this competition.

In trying to assess whether the four studied projects have conformed to the logic model illustrated above, my research assumed that there is a continuum of results; it is not a presence/absence metric. Finding the ideal set of funder interventions will not be an exact science, but rather like adjusting a weighted scale; one moves the weights in an iterative process of assessing and then adjustment to continually optimize science investments. The critical question is whether more efforts are required, and if so, what mechanisms should funders attempt to manipulate?

In reviewing the results for Research Question 1—is the science linking to decisions?—12 of the 16 interviewees felt the projects were linking science to decisions or were on a clear trajectory to do so (Table 16). On the other hand, all 16 interviewees indicated that more could have been done to better link science with decisions. The CA project is perhaps the ideal example. All interviewees agreed that the project was influencing how managers looked at salt marsh restoration and conservation in the area. Also, all inteviewees, especially Investigator 1, Investigator 2 and User 2, saw significant opportunities for improving the process and therefore the extent to which science linked to decisions.

These findings must be interpreted with caution. It is true that there was confusion about my definition of what it means for science to “link” to decisions, as evidenced by interviewee feedback on the NJ case. However, this confusion seemed limited to Research Question 1, where interviewees were asked to talk about how the project has or has not linked to decisions. In contrast, when asked about what funders could do to better link science with decisions, there was little confusion about the terminology. Therefore, the findings around whether and how funders should address better linking of science to decisions, which is the primary focus of this paper, should be relatively insulated from confusion around the “linking” terminology.

This research indicates that more can be done to better link science with decisions, but does it come with an increased risk or cost? The evidence from these interviewees suggest that the costs are time and money. As in Chapter 2, a notable finding is the significant amount of time that it takes to structure productive interactions that allow intended users more than a chance to simply hear what the scientists are up to. It was clear from these interviews (for example, see User 1 on the OR project) that funders should give more thought to fostering a clear and high-quality user involvement process.

Certainly, my direct observations corroborate the idea that the participatory processes for these projects could have been improved. Only the NJ project was assigned the highest score (5) in terms of meeting CICEET's expectations for designing interactions for maximum credibility, relevancy and legitimacy. (The CA project was extremely well organized, with the exception that the meeting participants were not as diverse as the problem warranted.) Both the OR and NH projects had generous amount of room for improvement in terms of how the meetings were organized and executed.

In other words, funders need to emphasize not only getting scientists and intended users together more, but also bringing more strategy and planning to the ways that these interactions occur so that participants collaboratively address the problems of mutual concern. If the results from these case studies apply to other case studies as well, this could be an important adjustment to the oft-heard advice for applied science funders. Instead of "make sure users and scientists interact more," the advice, based on these findings, should be "make sure users and scientists interact more AND make sure that these interactions are designed and implemented by professionals who focus on participatory processes."

Conclusions

The experience of these four projects leads to the conclusion that funders should increase efforts beyond those of this particular competition to better link science to decisions. Moreover, most observers have noted that this RFP (CICEET 2008a) was focused on user engagement to a much greater extent than the typical applied science RFP. Despite our efforts, however, interviewees wanted more accountability, more resources, more training/guidance, more time for user involvement, more practice with this challenging approach to research, more frequent meetings, and more diversity in the intended user groups.

In speaking with other funding program managers about this issue, three broad strategic options—none of which are mutually exclusive—tend to emerge. First, program managers can adjust what they ask for in RFPs; second, they can adjust how much support the program management staff gives to project teams; and third, they can adjust the review process. I will use my final paragraphs to discuss these three strategic opportunities in more detail.

<u>Adjusting What Kind of Science Activities Program Managers Ask For</u> Most RFPs are built to distribute funds to people who have already defined the problem, and yet often the problem has been defined only by the scientists or at an incomplete level of detail through a broad survey or workshop. Instead, program managers should demand documentation to show a more thorough problem definition (as noted by Investigator 2 in the NJ case). Alternatively, funders should actually fund the problem framing activitiy through the RFP. Otherwise, scientists and non-scientists are forced to do some of the most critical work—e.g., problem framing—without any funds, "on spec" as it were.

In addition, Ruegg and Feller (2003) have pointed out that science in the United States is more focused on knowledge generation than knowledge use. Funders should rethink the current emphasis on new and innovative knowledge and consider funding science that may be more mundane but potentially more useful to society.

<u>Adjusting What Kind of Support Program Managers Offer to Awarded Projects</u> Many funding programs operate akin to hospitals with regard to parents of newborn babies. The funding agency is happy to participate in the birth of the project but then the project team is on its own, with the exception of the exchanging of pro forma progress reports. In fact, CICEET operated according to this paradigm.

In contrast, some programs allocate much more staff time to continuing to work with projects after they are awarded. In this way, program managers can serve in the liaison role that emerged as valuable in two of the projects (see Table 16). NOAA's Center for Sponsored Coastal Ocean Research operates in this way. From the non-profit sector, the Packard Foundation serves as another good example (Packard 2010), with program manager embedded as a critical component of all the research projects that are funded.

<u>Adjust the Review Process</u> Most funding agencies give considerable thought to the credibility of the science they fund and so put great thought into the review panels they organize to assess submitted proposals. The assumption is that the proposal must show maximum attention to the state of the art of whatever science is being proposed (biophysical science or social science). Further, in order to assess the credibility of the methods, program managers call upon subject matter experts. For example, few program managers would ask decision makers to pass judgement on the credibility of methods to assess microbiological contamination of beach swimming waters, although they may ask decision makers to weigh in on the relevancy of those methods.

A great deal of work that has occurred over the last two decades has shown that the process by which users are engaged in science is critical and complex and requires expertise (e.g., Jacobs 2002; NRC 2006; NRC 2009). Moreover, I have shown (Matso 2012) that participatory process experts both exist and are, to an extent, disappointed that applied science programs continue to mostly ignore their potential contributions. These people focus on designing and assessing participatory processes in the real world. It seems incontrovertible that they should be as involved in applied science review processes as biophysical experts: especially if the funding program is truly determined to generate knowledge that gets used by people outside of academic and governmental circles.

CHAPTER 4

PUBLIC PARTICIPATION IN GRANT-AWARDED APPLIED COASTAL SCIENCE: A FORMATIVE ASSESSMENT OF A NOVEL APPROACH

Introduction

Coastal communities face many pressing ecosystem and resource management issues due to continuing pressures related to development as well as changes in weather patterns and climate. Those who fund science to address these pressures have been grappling with questions about how to best use scientific resources to help decision makers of all levels address the complex problems and choices that exist. One answer to the question of how to better link science with decisions crops up in many studies and reports: *involve users of the research to a greater extent and more frequently* (e.g., Jacobs 2002; Donahue 2007; McNie 2007; RATF 2007; Dreelin and Rose 2008; NRC 2006, 2007, 2009; Riley et al 2011).

The logic commonly cited (e.g., McNie 2007; NRC 2009) is that involving intended users as early as possible increases key attributes that in turn contribute to the linking of science to decisions. Three attributes often referred to (Cash et al 2003) include credibility, relevance and legitimacy. Credibility refers to whether all stakeholders perceive the information as meeting standards of scientific plausibility and technical adequacy. Relevance refers to the fit between the information produced and the specific needs and logistical constraints of the diverse stakeholders. Legitimacy refers to whether the process for determining research needs and methods meets standards of political and procedural fairness.

It is less common to see, however, an acknowledgement of just how difficult it is to "involve users" in a way that is productive or even non-injurious to the cause of better connecting science to decisions. In Chapter 3 of this dissertation, I noted how presuming that simply "getting scientists and users" in a room together—without a rigorous and thoughtful plan for how to manage the engagement—can actually lead to a decrease in key attributes such as credibility and legitimacy. In a previous article (2012), I also noted that many actors in the resource management enterprise (e.g., decision makers; resource managers; funders; social and natural system scientists) do not consider the design and implementation of participatory processes as an explicit skill or discipline, despite the fact that there are many professionals who specialize in this area. At face value, these two givens—1) agreement that we need to have more interactions between scientists and users, and 2) a lack of acknowledgement of participatory processes as its own expertise—seem to indicate a potentially problematic inconsistency in our society's approach to linking science to decisions.

The purpose of this study is to focus the spotlight on participatory processes and how six different projects—all of which were funded specifically to do a better job of linking science to decisions—approached the task of managing interactions between scientists and intended users of the science. Specifically, this article explores the extent to which initial or "kick-off" project meetings, involving both scientists and users, increased the credibility, relevance and legitimacy of the given research projects. The "Discussion" section examines steps process designers could take to improve meetings like those studied in this chapter. Finally, the discussion will build on the results to suggest specific ways that funders can help actualize any needed improvements.

Background

The funding organization in question is the NERRS Science Collaborative (hereafter referred to as "the Collaborative"), which is a five-year program representing a partnership between the University of New Hampshire (UNH) and the National Oceanic Atmospheric Administration (NOAA). The Collaborative began in 2009 in response to a NOAA call for a research program to support collaborative research within the National Estuarine Research Reserve System (NERRS), a network of 28 sites around the country, each one with a similar mission to conduct research, monitoring, education and stewardship.

The Collaborative's program managers were committed to three central and defining ideas: 1) linking of science to decisions had to be put on an equal footing with generating the science itself, whether that science dealt with engineering, ecology, geology, or social sciences. 2) It was an explicit goal and assumption of the program that the expertise and means to link science to decisions had to exist on the applicant team. This is different from related models where the linking activities are seen as being the responsibility of the program manager or someone else outside the team. 3) So that the science would be relevant to intended users, the Collaborative had few constraints with regard to the subject of the research. Rather, the emphasis in the Request for Proposals (RFP) was on proving to reviewers that the applicant team had grounded their problem definition with a sufficiently broad set of intended users.

Because of these three ideas, the RFP for the competitive grants program had some unusual characteristics. (For the complete text of the RFP, see Appendix C.) First, the weighting of the science generation methods were equal to the weighting for the methods for linking the science to decisions. Second, every team had to identify an "integration lead," whose job was to balance the perspectives of the scientists and the users. Third, the RFP contained a "primer" on collaboration with resources for learning more about how to better link science with decisions. In addition to the primer, the Collaborative hosted several opportunities for people from the NERRS as well as their partners to learn more about the RFP. Third, each submitted proposal was peer reviewed by two people with a background in the science being generated (e.g., salt marsh restoration; ecosystem valuation, etc.) as well as two people with a background in linking science to decision making. These latter reviewers come from a variety of disciplines, such as: sociology, anthropology, geography, and sustainability. Key phrases in the curriculum vitae of these reviewers include "participatory processes" and "human dimensions."

The Collaborative created an explicit "logic model" to articulate what the program sought to catalyze and what the expected outcomes—both short and long term—would be. Figure 9 represents a simplified version of this logic model.

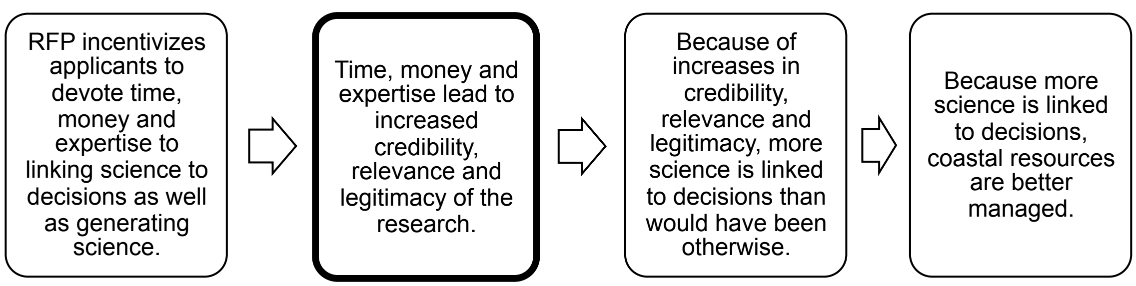

Figure 9: The Collaborative's expectations for how science would link to decisions.

This paper is focused on those first meetings between scientists and users and so is concerned with groundtruthing what happens in the bolded box, second from the left in Figure 9.

Thirty five Letters of Intent were submitted in response to the RFP. The invitation was clear that anyone who submitted a letter would be invited to submit a full proposal. The invitation included concerns and suggestions from the program staff, based on the content of the Letter of Intent. Six out of 35 applicants opted out at this stage, leaving 29 full proposals submitted. Each proposal was then sent to four external peer reviewers, two for the science generation and two for the linking of science to decisions; peer reviewers assessed between one and three proposals.

Applicants then had the opportunity to rebut the peer reviews. Finally, panelists from a range of backgrounds—academia, non-profits, private sector, etc—gathered to review the proposals, peer reviews and rebuttals. While some panelists were strong in education and outreach, no social scientists, collaboration experts or participatory process experts were used. Seven 3-year projects were funded. The projects began in the Fall of 2010 and are due to be complete in late 2013. This article uses six of these seven projects as its case studies. (One of the seven funded projects suffered several logistical setbacks and so did not start early enough to be included in this study.) See Tables 17 and 18 below for more information on those projects.

Methods

Four research questions guided this research. 1) To what extent did the meetings contribute to the ability of the project to link science to decisions? 2) What benefits or detriments were noted by participants? 3) What aspects of the meetings were distinctive to participants, as compared with other projects seeking to link science to decisions? 4) What critical elements should meeting designers focus on to better link science to decisions?

Analytical Framework This analysis employs a primarily qualitative approach. I use the term “qualitative” in the sense of Yin (2003) to indicate that I am not entering the study with any pre-conceived hypotheses that I am hoping to prove or disprove. Rather, I have identified a phenomenon of interest—that is, linking science to decisions—as well as some specific research questions concerning that phenomenon.

Table 17: Case Studies 1 through 3: project attributes based on what was in the proposal.

	Case 1	**Case 2**	**Case 3**
Project	Sustainable Shorelines and Ecosystem Services Along the Hudson River, NY	Land Use Change and Nitrogen Source Shifts at the Grand Bay Reserve, MS	Assessing Coastal Uplift in a Glacial Estuarine Ecosystem, AK
Objectives	• Characterize physical forces impinging on shorelines • Better understand how various kinds of constructed shorelines impact the ecology • Demonstrate a Best Practice design for mitigating erosion while maintaining a healthy ecosystem.	• Describe past and future land use changes in Grand Bay • Assess current and past nitrogen inputs • Connect changes in land use and nitrogen loading to ecosystem and human impacts	• Determine various uplift rates of habitats with diverse sediment structures • Refine models of uplift for future projections • Assess impacts on biotic diversity and community composition in affected salt marshes.
3-Year Budget	814,155	354,750	915,271
Key Personnel	Principal Investigator (PI) = Reserve Mgr. 11 co-investigators* (5 are physical/natural scientists; 1 is a non-profit manager; 3 helping with user engagement)	Principal Investigator (PI) = Physical Scientist 5 co-investigators (3 are physical/natural scientists; 1 is the Reserve Manager; 1 has expertise in user engagement)	Principal Investigator (PI) = Physical Scientist 8 co-investigators (4 are physical/natural scientists; 4 helping with user engagement)
Scientific Activity Person Effort (mo/year)	19	35	14
User Engage Activity Person Effort (mo/year)	5	.5 (two weeks)	7
User Engagement Activities	• 4 stakeholder workshops per year • 2 all-day outreach events • Multiple informal communications	• 2 stakeholder workshops per year • Multiple informal communications	• 4 stakeholder workshops per year • Significant citizen science activity • Multiple informal communications

For each of the six projects, six project participants were interviewed: two from the project team and four from the user audience. When possible, the two project team

Table 18: Case Studies 4 through 6: project attributes based on what was in the proposal.

	Case 4	Case 5	Case 6
Project	Ecological & Economic Tradeoffs of Riparian Buffer Management Choices, ME	Nitrogen Sources and Transport Pathways in the Great Bay Estuary, NH	Impacts of Land Use and Stormwater Runoff on Water Quality for the Grand Strand, SC
Objectives	• Describe ecological & economic tradeoffs of riparian management alternatives. • Use social science methods to target most critical users and critical messages for linking science to decisions. • Evaluate success of various communication approaches	• Map nitrogen hot spots in surface waters • Identify sources of N that create hot spots • Characterize flow paths that deliver N to these sites • Determine N removal rates by various buffers • Quantify nitrate rates of attenuation in rivers	• Quantify terrestrial nutrients and organics from stormwater and groundwater • Connect nutrients to organic matter prod-uction in tributaries • Determine net export of material from these tributaries.
3-Year Budget	641,285	599,514	872,732
Key Personnel	Principal Investigator (PI) = Social Scientist 9 co-investigators* (4 are physical/natural scientists; 2 are economists; 1 is a social scientist; 2 helping with user engagement)	Principal Investigator (PI) = Physical Scientist 6 co-investigators (4 are physical/natural scientists; 2 have expertise in user engagement)	Principal Investigator (PI) = Physical Scientist 8 co-investigators (4 are physical/natural scientists; 4 helping with user engagement)
Scientific Activity Person Effort (mo/year)	8	14	31
User Engage Activity Person Effort (mo/year)	8	2	2
User Engagement Activities	• 4 stakeholder workshops per year • Several focus groups re: choice experiment surveys • Multiple informal communications	• 3 - 4 stakeholder workshops per year • Many smaller and one-on-one meetings with diverse users	• 2 stakeholder workshops per year • Multiple informal communications

interviewees represented someone charged with generating knowledge related to the biophysical or social science as well as someone charged with focusing on how to link the research with decisions.

In addition to the interviews, the author directly observed initial meetings between project investigators and identified intended users of the research. Richards and Morse (2007) note that direct observation provides opportunities to collect data not obtainable by simply asking participants questions. For example, in some cases, participants may not be aware of their own behaviors or attitudes. In addition, the researcher may have a unique perspective on the issue. In their book on “grounded theory”—an often used approach within the discipline of qualitative research—Strauss and Corbin (1990) refer to this specialized knowledge as “theoretical sensitivity.”

Direct observation occurred in the following manner. I was introduced at the beginning of the meeting as a staff member of the NERRS Science Collaborative who was present to observe but not to participate. I refrained from asking any questions or making any comments throughout the meeting. I used a pre-written protocol, adapted from Yin (2003), that specified the type of information I was intending to capture (see Appendix E). This included: explicitly stated purpose of the meeting; physical layout of the room; and the number of people present and their explicitly stated roles.

The protocol provided specific spaces for recording behaviors and interactions that could have affected the linking of science to decisions, either through increasing/decreasing credibility, relevance or legitimacy (Cash et al 2003) or through any other means. In addition, the protocol required a rating of the meeting’s ability to achieve objectives related to linking science with decisions. Five ratings were possible. A “5” indicates that the meeting met or exceeded Collaborative expectations (see below) and there were no exceptions to this rule. A “4” indicates that, overall, the meeting met expectations, but there were definitely some opportunities for improvement. A “3” indicates that the meeting was mixed with roughly half meeting expectations and half falling short of those expectations. A “2” indicates that the meeting mostly did not meet Collaborative expectations, with a few exceptions. A “1” indicates that the meeting did not resemble the Collaborative’s expectations in any way.

Interpreting these ratings requires an understanding of the Collaborative’s expectations, which were noted in the RFP but not as succinctly as in the following few sentences. The program expected that the project teams would: 1) do a thorough job of exploring the diversity of users interested in the results of the project and invite representatives of those groups to the initial meeting; 2) design the meeting in such a way that it invites input from the users on the basic assumptions of the research as well as the specific methods; and 3) facilitate the meeting so that everyone involved is able to contribute and feels their contributions are valued.

These expectations come from the Collaborative’s own experience in learning how to better run meetings to address complex issues. Over the past years, staff members have become familiar with project planning and design techniques as well as facilitation methods. For examples of these materials, see the NOAA Coastal Services Center web site (Coastal Services Center 2012). In addition, these expectations come from studying common models for addressing complex environmental issues, such as: Collaborative Learning (Daniels and Walker 2001) and Joint Fact Finding (Ehrmann and Stinson 1999). Finally, these expectations derive from watching or participating in processes facilitated by skilled practitioners.

<u>Interviewee Selection</u> For all six projects, choosing the two project team investigators to interview was fairly straightforward. Due to the nature of the RFP, it was very clear who on the project had responsibility for the tool or science generation and who had more responsibility attached to actually linking science to decisions. With regard to choosing four people from the target user audience, the initial research

proposals were used so that I could suggest some names to the project investigators. In communicating with the project investigators, I often asked, “Of the following users, please name four who you would especially want to actually use and be satisfied with this tool given that you want this tool to have maximum benefit on coastal resources.” As a secondary criterion, I sought as much diversity in perspectives as was possible while still conforming to the first criterion.

Data Collection and Analysis Interviews were conducted using a semi-structured format so that the researcher could follow-up or ask unscripted questions when it seemed required for understanding the phenomenon of interest. The interview questionnaire had the following six questions:

1) Please state your position and how you plan to be involved with this project.
2) One aspect of this project is to better connect science with decision making. Please rate the extent to which this meeting contributed to this goal? *(Choices = significant negative effect; slightly negative effect; no effect; slight contribution; significant contribution)*
3) Please discuss up to three reasons for your rating.
4) Please name up to three ways you would change the meeting approach in order to improve it.
5) Have you participated in similar collaborative research projects before? (“Collaborative research” defined as investigators and users working together to define the problem, carry out the research and link the research to decisions.)
6) At this point, how has this project experience been different, if at all?

All interviews were conducted over the phone. Interviews were recorded using Garage Band software on a MacBook Pro computer. These electronic files were then exported to NVIVO 9.0, a qualitative research analysis software package that facilitates the organization and analysis of qualitative data. This process is often referred to as “coding,” which simply refers to the placing of parts of the interview (e.g., sentences, paragraphs, etc.) into labeled categories in terms of how they relate to the phenomenon of interest.

For this study, I used the research and interview questions to create a framework to hold the specific categories. These "parent categories" consisted of: "benefits/detriments," "comparisons with other research projects," and "critical elements of a good meeting." Within these parent categories, specific categories were created as they emerged from the data, as opposed to being pre-determined. For example, the following transcript snippet was the first part of the first interview I analyzed: "The reasons for my rating are that, one, it does bring together users and decision makers--some of the folks on our advisory board are actually decision makers and users of this information. Having them there, able to express their reservations or identify the things they like or shape how we move ahead is really valuable."

Since no codes yet existed within the parent categories, I created two new categories within the "benefit" parent category: "increased relevance," and "opportunity for people with diverse views to interact." For subsequent transcripts, I could code data to these existing categories or create new ones if the existing categories were inappropriate. Consistent with the grounded theory approach, creation and analysis of categories is an iterative and dynamic process as more and more data is gathered. Categories may be renamed and or divided into two if it serves to provide better explanations of the phenomenon being studied (Strauss and Corbin 1990; Charmaz 2006).

As one can imagine, many coded categories can and do arise as interviews are analyzed. How then does one decide which categories are most important? In contrast with quantitative approaches, which often involve statistical analyses, the qualitative approach seeks to focus on those explanations that 1) provide the closest fit with the data; 2) are most useful and 3) explain the most about the phenomenon (Strauss and Corbin 1990; Charmaz 2006).

Using these criteria, I usually focus on those ideas that emerge most often. Does this mean that the ideas mentioned by fewer people have less validity? I do not believe so. However, in the final analysis, funders need to target those ideas that have the highest likelihood of being relevant. Also, with regard to linking science to decisions, perceptions of what is true—whether true or not—are worthy of consideration. Science links to decisions through people, and people's perceptions are what provide and remove opportunities for linking. Therefore, if an idea seems to be held by multiple people across multiple case studies, I assert that it may warrant more attention from funders.

<u>Caveats Related to the Methods</u> First, I acknowledge that interviewing four user representatives does not allow me to generalize findings to a population of 25 or more users that may be at a meeting. Rather, it allows me to gain insights into the thoughts and experiences of a sub-sample of the population. Also, the feedback from these interviewees does allow me to "generalize to theory" wherein a theory—in this case, the Cash et al (2003) theory of attributes that lead to better linking of science to decisions—is used as a template with which to compare empirical results of a case study (Yin 2003).

It is important to point out that the author is not only acting as a researcher but also as a program manager for the NERRS Science Collaborative, helping to write the RFPs and run the review processes. Some may believe this disqualifies this research as being "subjective." However, within qualitative methods such as "grounded theory" (Strauss and Corbin 1990) as well as other policy sciences disciplines such as action research (O'Brien 1998), ethnography (Yin 2003) and natural resources policy studies (e.g., Clark 2002), the researcher can both study and be a change agent in the context of the study. In grounded theory, the specialized knowledge of the researcher is referred to as "theoretical sensitivity" and this is brought to bear to improve explanations for the observed phenomena. In my case, as a program manager by profession, I have an advantage in taking various kinds of feedback and translating that feedback into options for other program managers. At the same time, I have to be transparent about my biases, which have the potential to distort the explanations.

In this case, my bias, based on experience and my own orientation towards natural and social sciences, is that many applied science funding programs under-emphasize the human dimension aspect of natural resource problems. In my view, this is mostly done due to convention and the history of science and technology policy in this country, which has put much more emphasis on generating new knowledge and much less emphasis on diffusing that knowledge (Tornatzky 1990; Ruegg and Feller 2003).

Finally, it must be acknowledged that the interviewees themselves have their biases. While some effort was chosen to get a diversity of biases, the population I had to choose from—the people participating as intended users—is constrained by the choices of the investigators as well as the participants themselves. Therefore, there are undoubtedly many biases that have not been included in this study.

Results

In this section, I will first delve into each of the six studies, reporting on salient results under each research question heading. I will use direct quotations from interviews to explain the categories that emerged from the qualitative analysis. This is followed by an overview encompassing findings at the cross-case level, for all six projects, using the research question headings as a framework for presenting findings.

Case 1: Sustainable Shorelines and Ecosystem Services Along the Hudson River, NY

This project is attempting to address threats to habitats along the 152-mile Hudson River (see Figure 10 below) due to development, sea level rise and human efforts to prevent erosion in front of shoreline properties. It builds on a previous project that investigated ecological, engineering and economic tradeoffs among different shoreline treatments.

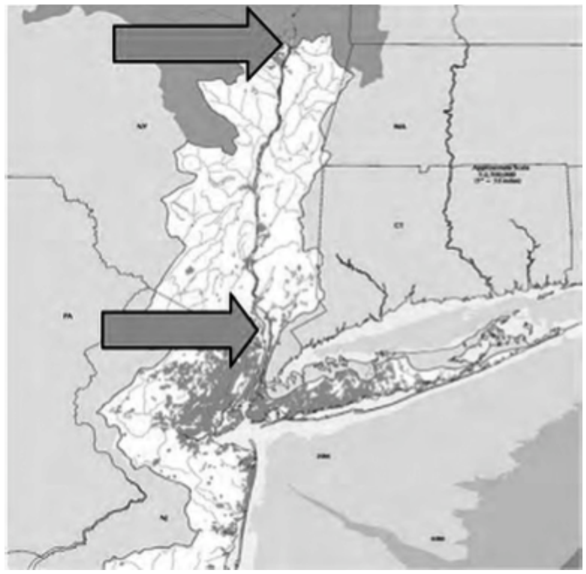

Figure 10: Map of Watershed of Hudson Estuary and New York Bight, with the area covered by this project located between the arrows.

This second phase has several elements, including 1) characterizing physical forces on shorelines, 2) exploring how different shoreline treatments affect ecological processes, 3) developing a demonstration site testing an innovative shoreline treatment, and 4) integrating these elements together with guidance and decision support tools.

The initial project meeting involving diverse users took place May 6, 2011, at the Hudson River Estuarine Research Reserve in Staatsburg, NY. The meeting was four hours long. Not including the project team, approximately 25 intended users attended the meeting, representing private engineering firms, non-profits, the railroad and state, regional and federal agencies. The agenda listed the main objectives as: 1) learn about previous project results; 2) get input on approaches to learning people's shoreline preferences; 3) ground truth results on how people make shoreline decisions; and 4) ID groups/topics that are missing.

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11 below, three of the intended users gave the meeting the highest rating, while the investigators (the reserve manager and an ecologist on the project) and one of the intended users gave the meeting the second highest rating. The interviewees gave the following reasons, respectively, for not using the highest rating: could have used more time for discussions; just too early to give highest rating; and not sure how much the meetings themselves, as opposed to the actual output of the project, really contribute to linking of science and decisions.

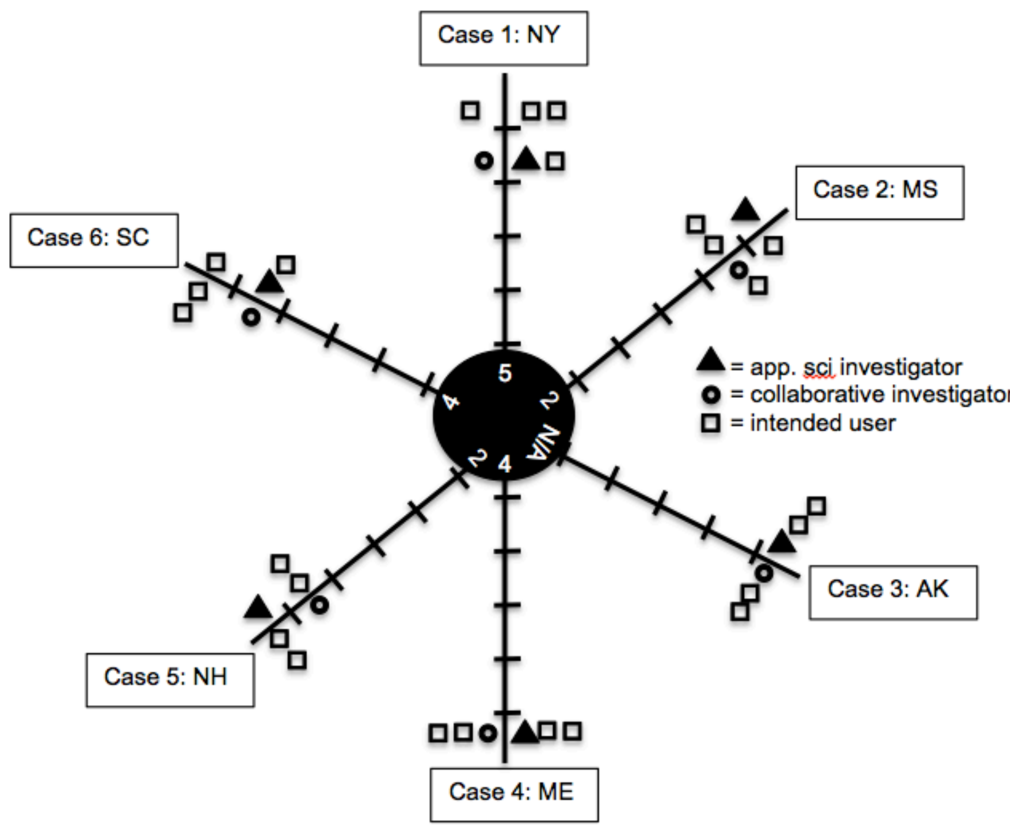

Figure 11: Radar map showing interviewees responses to question about the meetings' ability to contribute the goal of linking science to decisions. The question offered a five-point scale. Lowest ratings would appear near the tick mark closest to the black circle in the middle. Highest rating show up near the tick mark closest to the text box identifying the project. White text within the centered black circle indicates the author's rating of the meeting, with 5 being the highest and 1 being the lowest.

Research Questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 19 below indicates that five benefits were noted by the interviewees.

Table 19: Categories relating to Research Questions 2, 3 and 4 for the NY project.

Coding Category - Benefits	Case 1, NY
More relevance	5
Chance for interaction of diverse views	4
Strategy for communicating findings	4
More legitimacy	2
Develops valuable relationships	1
Coding Category – Project Distinctions	
More up front collaboration	4
User involvement more extensive	3
User input can alter research design	2
Collaboration is more explicit	2
Collaboration is more structured	2
Project accountable re collaboration	1
Coding Category – Critical Elements	
Expand diversity of users	4
More user participation, less listening	3
Encourage prep work from participants	3
Focus on communication in/out of mtng	2
Ensure significant time for discussion	2
Provide well organized materials	1
Have a good facilitator	1
Hold meetings more frequently	1
Involve social science	1
Provide a record of meeting minutes	1

The benefit category "Chance for interaction of diverse views" is, in some ways, not necessarily a benefit but rather a step that leads to other benefits such as increased relevance, better communication, etc. The other benefits have already been discussed above. As shown in this exchange below, the principal investigator for the project, also the reserve manager, credited the project as well as the prequel to this project (funded in 2009) with having much broader impacts than she, or the program for that matter, envisioned:

> What this questionnaire doesn't capture, and what you might want to capture at some point is: Does this change how a PI does business? Because I have to

say...I'm a believer now. I'm prepared to do this in a much more structured way moving forward.To the extent where we're now thinking about having 3 or 4 or more research meetings, some on elements of this project, some on elements that go beyond this project, but basically using the same kind of very explicit invitation to people to gather their input and using the language...self-identifying as a collaborative project.

> It’s also allowed us to access information we couldn't have, wouldn't have known. So, it's enriched our understanding of the issues and which way to go. It's also helped developed relationships with our intended users that have spin offs on other things. I've now established relationships—or strengthened relationships—that are going to have spillover effects in everything habitat-related that I do. And then it's just personally rewarding to do business this way.

With regard to Research Question 3—project distinctions—two interviewees noted the increased structure and explicitness of the collaboration. This was in a positive context in contrast with some interviewees from other projects who felt that the collaborative nature was too formal or overly belabored. Finally, one interviewee noted, as several others did from the MS project and the NH project, that it was distinctive to be held specifically accountable for collaboration.

Regarding Research Question 4—critical elements of meetings that link science to decisions—the main themes discussed earlier in the cross-case analysis were dominant for this project. While the diversity of users was impressive, there were calls for increased diversity. Perhaps distinctive from other projects was the finding that half the participants felt that using people’s time before the meeting was an important and under utilized way to get more contributions from the users (see Table 19).

<u>Direct observation: NY case</u> As shown in Figure 11 above, I assigned the meeting a rating of “5.” In particular, the author noted at least 18 instances where the perceived relevancy of the project was potentially improved. For example, when asked about gaps in the current research design, one intended user asked: “What drives changes to the shoreline? Development, Disaster...what? Certain agencies will get involved depending on the drivers. That needs to be part of the project, so you can ID

major players." The investigator then discussed ways that the project was intending to respond to this point and asked for more feedback from the users about the approach.

Legitimacy was also potentially increased for three reasons; one, meeting designers effectively structured the day to make sure that users got plenty of time to contribute and interact; two, the tone of the meeting was very deferential to users with the project team stating often that this was not to be “top-down” exercise; three, the meeting was facilitated especially well, in this author’s opinion. Two facilitators from the Consensus Building Institute helped run the meeting, one person making sure that everyone was heard from and the other taking notes. When people wanted to speak, they changed the orientation of their name placard and one of the facilitators maintained a running queue of participants who had a question or comment. From a procedural fairness standpoint, the meeting was pretty much faultless.

There was less evidence that credibility was enhanced because the day was mostly devoid of technical matter, although credibility with regard to social science competence may have gone up in reaction to a well-received presentation on how social science could be dovetailed into the project.

With regard to potential improvements, the Direct Observation notes only reflect that some PowerPoint presentations may have gone on a bit too long, with the author noting: “I wonder if we can make these meetings more interactive?”

<u>Case 2: Land Use Change and Nitrogen Source Shifts at the Grand Bay Reserve, MS</u>

Although the Grand Bay Estuary (see Figure 12 below) is one of the largest estuaries on the Mississippi/Alabama coast, it relatively unstudied, which makes it difficult to tackle emerging concerns about the habitat and fishery related impacts from new wastewater treatment facilities, ongoing release of fish processing waste, and sources of pathogens

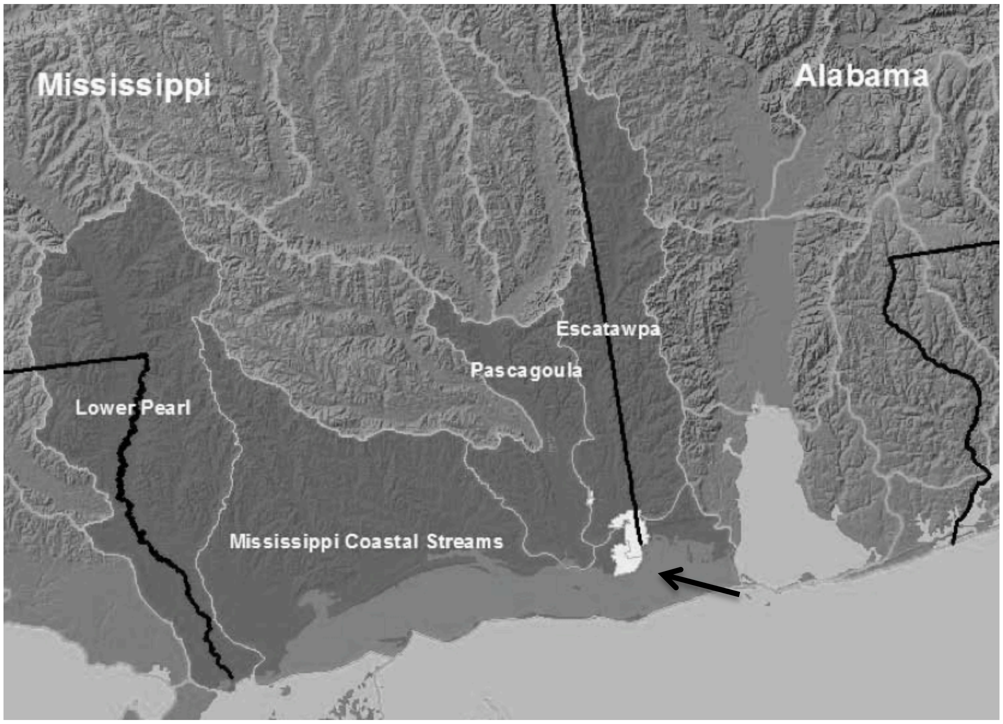

Figure 12: Map showing the watersheds surrounding the Grand Bay Reserve, which is light colored and indicated by the black arrow.

that may influence growth and sanitary condition of oysters: not to mention impacts from the Deepwater Horizon oil spill.

The goal of this project is to jumpstart an ambitious research program in the area focused on measuring land-use related N source and pathogen changes through time, defining the resulting effects on ecosystem and human health by using Grand Bay as a benchmark estuary. Specifically, as part of this 3-year project, researchers aim to combine data from land-use models, sediment cores, modern sediment and water samples, ancient shell deposits and living and transplanted bivalves for three subwatersheds and their receiving waters. As information is collected, the project team aims to involve intended users in discussions of the management implications of the scientific findings.

The initial project meeting involving users as well as all the project team members took place March 4, 2011, at the Grand Bay Estuarine Research Reserve in

Moss Point, MS, and lasted two hours. The meeting was comprised of ten people: the team's various scientists and collaboration experts as well as four intended users: two federal agency microbiologists, an archaeology professor who was seen as a potential collaborator on the project as well as the owner/operator of an ecotourism business. The agenda listed the main goal of the meeting as getting on the same page with regard to the project goals and make sure everyone had a chance to weigh in on the project approach.

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11, one of the intended users as well as the supervising ecologist on the project gave the meeting the highest rating, while the collaboration lead and three of the intended users gave the meeting the second highest rating. The interviewees gave the following reasons, respectively, for not using the highest rating: needed more intended users; just hesitant to give highest rating; (no reason given); and not sure the goal of the meeting was to actually begin linking science to decisions.

Research Questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 20 below indicates that six benefits of the meeting were noted by the interviewees, none of which require further elaboration. With regard to Research Question 3—project distinctions—it is notable that three of the six interviewees remarked on the project team's accountability for collaboration. One investigator noted: "I think it's different in that the funding agency is much more involved, in the sense that you are holding the researchers directly accountable for exactly what we're doing right now, which is having this kind of feedback and interaction. Really pinning us down on demonstrating that we're actively involving stakeholders."

As noted earlier, the collaboration lead on the project, coming from an extension background, felt that the project was less grounded in user needs than the typical extension project. Still, he praised the project and his colleagues for working to make their scientific questions more relevant to users. As seen in Table 20, he also noted that the collaboration paradigm encouraged by the RFP was more academic and process focused than he was used to. In contrast with other interviewees, he noted that some users could potentially be put off by too much attention paid to collaboration because “they're not talking about what they were interested in; they're talking about the process.”

Regarding Research Question 4— critical elements of meetings that link science to decisions —Table 20 clearly shows that the team was well aware that this early meeting was just the beginning of the process of identifying and assembling more intended users. All but one of the interviewees made reference to this in their interviews.

Table 20: Categories relating to Research Questions 2, 3 and 4 for the MS project.

Coding Category - Benefits	Case 2, MS
Chance for interaction of diverse views	3
More relevance	2
Builds awareness of project	2
More legitimacy	2
Builds understanding of project goals	1
Helps to assess other users to invite	1
Coding Category – Project Distinctions	
User involvement more extensive	3
Project accountable re collaboration	3
User input can alter research design	2
Collaboration is more explicit	1
More up front collaboration	1
More scientist-based than user-based	1
Collaboration is more academic	1
Collaboration is more process focused	1
Coding Category – Critical Elements	
Expand diversity of users	5
More user participation, less listening	1
Ensure significant time for discussion	1
Have a good facilitator	1
Give users a chance to visit the field	1

Direct observation: MS case I assigned the meeting a rating of “2” for one very clear reason: the low number of intended users (Figure 11). Beyond that, direct observation notes indicate that the meeting was run well and probably enhanced the relevance and legitimacy of the project, although the impact of this enhancement is mitigated by the low number of intended users. The notes document between 5 and 10 separate instances of users making suggestions about the research, with the investigators noting the comments and talking about how they will be incorporated.

Legitimacy was most likely enhanced, since the meeting organizers attempted to include the users as much as possible and were explicitly deferential to user contributions and interests. Credibility may have also been enhanced as there was some, though not a lot, of technical discussion regarding methods, and the scientists present were well in command of the subject matter. Again, this is difficult to assess with the small number of intended users. Nevertheless, judging by the body language and facial expressions of the users present, the technical information was delivered in an acceptable manner.

In terms of improvements beyond involving more users, the notes suggest that the facilitator could have perhaps been more diligent and creative in getting input from the users and making sure that they were on the same page as the investigators with regard to the basic premises of the project.

After the meeting, the author discussed the intended user situation with the project team and it became evident that there was, in fact, a misunderstanding between the program (including the reviewers of the proposal) and the project team about the nature of the collaboration. The program interpreted the proposal as saying that it had already begun to involve the many users necessary to link science to decisions in an effective manner; however, the project team’s view was that this process would begin and grow after the initial project meeting. Since that initial meeting, the project team has taken steps to broaden the intended user groups, as evidenced by their recent progress reports (NERRS Grand Bay 2012). This misunderstanding may point to a weakness in the Collaborative's review process. See "Discussion" section for more on this discrepancy.

<u>Case 3: Assessing Coastal Uplift in a Glacial Estuarine Ecosystem, AK</u> In and around the Kachemak Bay NERR in Alaska (see Figure 13, below), coastal communities rely on the nearshore habitat for transportation, safe harbor infrastructure, and food resources.

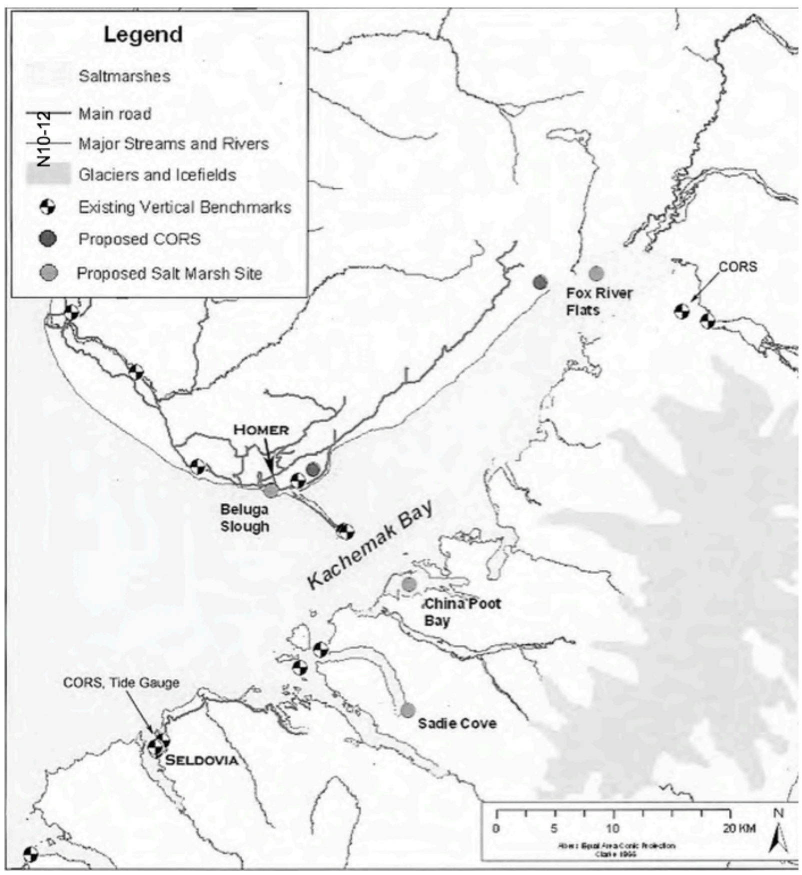

Figure 13: Map of Kachemak Bay Estuary in Alaska.

In 2009, in response to reports on isostatic rebound from melting glaciers as well as sea level rise, community leaders approached the Reserve staff and asked for help in understanding what is and will continue to happen to the habitats in the area. It seems that coastal uplift is outpacing sea level rise but managers need more information in order to guide their decisions. The goal of this project to gain a better understanding of the variability in coastal uplift around Kachemak Bay as well as what the net effects of these changes might be on coastal ecosystems in the area. Towards that end, researchers plan to test how different types of sediments (e.g., bedrock, unconsolidated glacial till, etc.) are responding to coastal uplift. Models will be refined to better predict uplift in the future. Also, they intend to monitor the vegetation shifts that may occur on the salt marshes in the Bay as well as study how salt marshes differ depending on whether they are fed by glacial melt water or not.

The initial project meeting involving diverse users took place November 30th, 2010, at the Kachemak Bay Reserve in Homer, AK. The meeting was five hours long. Not including the project team, approximately 20 intended users attended the meeting, representing the City of Homer, a regional governing body (Kenai Peninsula Borough), a state agency, a local tribe, other scientific institutions, federal agencies and the Reserve community council. The agenda listed the main objectives as: 1) reviewing the principles of Collaborative Learning; 2) getting input on best way to communicate the scientific findings; 3) identifying groups/topics that are missing; and 4) going over the research approach.

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11, all of the interviewees gave the meeting the highest rating possible.

Research Questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 21 below indicates that six benefits were noted by the interviewees. All of these categories have been dealt with previously or are self explanatory. However, the following quotation from the lead scientist on the project provides one of the clearer examples of a discussion around legitimacy:

> I opened with a short presentation talking about how we got here, a little reminder of what this project's all about. I started by working backwards from where we wanted to be in three years, and then I said we're going to then go into greater detail about the methods for each component and the collaborative methods…and what came out right away was…Who makes the decisions in the report? How do you present information? How much of your bias goes into that? It was very interesting. As a person with a scientific background, I was like, 'Well, the data say it. I don't say it.' And it came around to a discussion of: 'Well, even scientists have biases."

The collaboration lead referred to this same exchange, noting: "The meeting brought up questions that people had reflecting their distrust in science. That's great because we can address this right now, but it was clear to me that hopefully through this process, people will be more trusting of the process itself, and how we've done the science."

Table 21: Categories relating to Research Questions 2, 3 and 4 for the AK project.

Coding Category - Benefits	Case 3, AK
Chance for interaction of diverse views	4
More relevance	3
Builds understanding of project goals	3
More legitimacy	2
Strategy for communicating findings	2
Helps to assess other users to invite	1
Coding Category – Project Distinctions	
Collaboration is more explicit	3
User involvement more extensive	2
Collaboration allocated more funds	2
User input can alter research design	2
More up front collaboration	1
More disciplines involved	1
Collaboration is more structured	1
Coding Category – Critical Elements	
Expand diversity of users	3
More user participation, less listening	3
Focus on communication in/out of mtng	3
Ensure significant time for discussion	1
Clearly describe roles & project design	1
Provide a record of meeting minutes	1
Don't belabor the collaboration process	1
Choose a pleasant meeting location	1
Strike a positive tone	1

With regard to Research Question 3—project distinctions—unlike other projects, two interviewees noted the distinction that collaboration activities are better supported by dollars. The collaboration lead noted: “The distinction truly is that if it's valued enough than it's part of the funding itself, and then we get to structure our timing...instead of just having a report at the end, there's actual time built into the whole process for engaging stakeholders and outreach and communicating.”

Regarding Research Question 4— critical elements of meetings that link science to decisions —the main themes discussed earlier in the cross-case analysis were dominant for this project (e.g., “expand diversity of users,” “more user participation, less listening,” etc.). Interestingly, one of the four intended users felt that too much of the meeting was spent discussing the details of the collaborative learning process, especially since, in his opinion, collaboration is something most people are familiar with: “I would have spent less time talking about the collaborative process. I think it's important, but I think we spent a lot of time on it, and most of the policy makers in the room use a collaborative process already. We call it something different...’involving stakeholders’ and ‘reaching out to stakeholders’ and stuff, so I think the concepts are not new.”

Direct observation: AK case I was unable to observe this meeting as it was scheduled for the same day as the SC project (Case 6).

Case 4: Ecological & Economic Tradeoffs of Riparian Buffer Management Choices, ME

Ongoing land use changes in watersheds in and around the Wells NERR (see Figure 14 below) exemplify common stressors to sustainable coastal ecosystems. In this area, riparian buffers and wetlands are coveted by developers and home owners, and they provide important water quality services due to their ability to filter nonpoint source pollution. Some people living in this area are concerned that land use decisions do not reflect the long-term best interest of the public, because there is a lack of capacity to accurately consider tradeoffs between the costs/benefits of development and the associated losses of ecosystem services.

The goal of the proposed project is to provide this tradeoff information in a concrete, useful format, and to use this information in coordination with Wells NERR stakeholder groups to promote sustainable management of riparian land use and habitat. Coordinated ecological/economic models and associated outreach activities are being developed with data that include: (1) spatially-explicit land use data for the affected watersheds, (2) data on biogeophysical processes, water quality and habitat from Wells NERR monitoring and research, (3) survey data on area households' characteristics, attitudes, knowledge and resource uses/activities, and (4) results from survey-based choice experiments characterizing households' preferences and values for specific ecosystem services and related tradeoffs, revealed through choices over multiattribute policy alternatives.

Figure 14: Map showing area in Southern Maine where this project and the Wells Reserve is located.

The initial project meeting involving diverse users took place December 8, 2010, at the Wells Estuarine Research Reserve in Wells, ME. The meeting was two hours long. Not including the project team, approximately 15 intended users attended the meeting, representing state agencies, town planning departments and non-profits interested in conservation. The agenda listed a short summary of the funded project and the facilitator noted early in the two-hour segment that the purpose of the meeting was to discuss the project, hear about some of the communications and economics work planned, and to hear from the intended users.

It should be noted that this two-hour meeting was one component of a longer meeting dubbed "Regional Natural Resources Provider's Summit," which lasted from 9 a.m. to 2 p.m., including a working lunch. The collaborative project portion of the meeting occurred between 10 a.m. and noon.

Table 22: Categories relating to Research Questions 2, 3 and 4 for the ME project.

Coding Category - Benefits	Case 4, ME
Builds understanding of project goals	4
More relevance	2
More legitimacy	1
Strategy for communicating findings	1
Help to assess other users to invite	1
Coding Category – Project Distinctions	
More up front collaboration	3
User involvement more extensive	2
User input can alter research design	1
Partnership with a National Estuarine Reserve	1
More likely to produce useful information	1
More disciplines involved	1
Coding Category – Critical Elements	
Expand diversity of users	5
Focus on communication in/out of mtng	3
Ensure significant time for discussion	2
More user participation, less listening	2
Build project on previous relationships	2
Provide well organized materials	1
Encourage prep work from participants	1
Hold meetings more frequently	1
Involve social science	1
Ensure users see benefits to attending	1

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11, this was one of two projects where all six interviewees gave the meeting the highest rating possible. One of the intended users, a conservation organization staffer, gave his high rating with a fairly significant caveat, however: “The problem is that I think we’re all starting with the assumption that science impacts decision making.” He then discusses why he thinks this assumption is false. “There are all kinds of studies out there, really professional economic studies that basically show the economic benefits of land conservation. And you can present those studies to decision makers and it still doesn’t change their mind.”

Research questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 22 above indicates that five benefits were noted by the interviewees. In particular, people appreciated the chance to learn more about the project goals and how they would be achieved. In fact, three of the four intended users—as well as one of the two investigators interviewed—commented on the special value and complexity of the project’s subject: namely, using economics to better understand ecosystem values of riparian buffers. The state agency biologist noted: “I appreciated having the two powerpoints from the two Clark University folks further explaining what the project was about, because I particularly didn’t know about the economic side and how you do those choice surveys and narrow things down, so I thought that was good.”

With regard to Research Question 3—project distinctions—six distinctions emerged from the qualitative analysis. “More up front collaboration” and “user involvement more extensive” were noted by three and two people, respectively (Table 22). The comment on “more likely to produce useful information” reflects some frustration on the part of one of the planners with regard to effectively conveying information to decision makers. When asked how this project might be different, this planner responded: “Hopefully, by generating information that we can use to educate decision makers. Planners are constantly in need of better information to guide decision making, and it's becoming more and more difficult to—especially with land use regulations—to get all the decision makers on the same page."

Regarding Research Question 4— critical elements of meetings that link science to decisions —ten elements were noted by interviewees, with five of them noted by multiple interviewees (Table 22). The main themes discussed earlier in the cross-case analysis were dominant for this project, with the addition of two comments on how important it is to build a project on a foundation of previous relationships, when possible. Perhaps most notable is the result that five of the six interviewees mentioned the importance of involving diverse users. For this project, two of those five comments implied that the existing group was quite diverse, while three comments suggested the group needed to branch out beyond the "choir." One intended user expressed the notion that more people need to be brought in, but also that it may have been sufficient—for this initial meeting—to start with a core group of users.

Direct observation: ME case I assigned the meeting a rating of "5," though I considered assigning it a "4." (See Figure 11.) The author noted at least 20 instances where the perceived relevancy of the project was potentially improved. The excerpt below provides a good example of how user input seemed to already be paving the way for a potential adjustment to the project:

> User: People need to understand that more development means higher taxes, not less. Here in Wells, if beaches keep getting closed, it'll bring those neighborhood tax rates down. In Rhode Island, some of those places are trashed and they're trying to make them better. Here's it's still good and we want to keep it that way.
>
> Investigator: In the choice surveys we create, it would be great if you could help us come up with examples of "trashed" places that will resonate with people.
>
> User: (nodding his head in the affirmative) That would be extremely helpful, because most riparian owners aren't aware of this.

Legitimacy was also potentially increased for the same reasons mentioned with the NY and MS projects: namely, users had plenty of time to contribute and interact; and two, the tone of the meeting was very deferential to users. In contrast with the NY project, the facilitation style was less formal. The author's direct observation notes show several comments noting the desire for more "framing," such as laying out more clearly the objectives of the meeting, and more proactively ensuring that everyone contributes, not just those who tend to speak the most. On the other hand, the facilitator intervened at key points to create opportunities for others to offer feedback. The difference between the NY and the ME project facilitation could simply come down to contrasting styles; it could also relate to the ME project's smaller group and the fact that most of the group was very familiar and comfortable with each other. Also, the direct observation notes indicate some frustration with the slide presentations: their legibility, length and the appropriateness of the material for the lay audience. Finally, in comparison with the NY Project meeting, which was a clearer "5" in my opinion, the meeting seemed to lack key intended user audiences, although the investigators plan to bring these missing constituencies into future meetings.

Credibility was most likely enhanced by the meeting as users asked many difficult questions about the economics methods and received very complete answers from that investigator. For example, one of the users asked, "How far afield can you take the information? Can you extrapolate?" The investigator gave a very thorough answer, during which the author noted many appreciative nods from the audiences.

Case 5: Nitrogen Sources and Transport Pathways in the Great Bay Estuary, NH

Nitrogen concentrations have sharply increased in the Great Bay Estuary, NH (see Figure 15 below) over the last 20 years. While most of the surrounding communities have a general idea of where the nitrogen is coming from—wastewater treatment plants, atmospheric deposition, non-point source pollution—and in what proportions, management options are stymied, in part because of lack of information about the exact pathways the non-point source nitrogen is taking from land to the estuary.

To address some of these information gaps, this project will: 1) map the nitrogen hot spots in surface waters within the watershed; 2) identify the sources of nitrogen that result in these hot spots; 3) characterize the flow paths that deliver nitrogen to these hot spots; 4) determine whether nitrogen removal occurs in vegetated riparian buffers with different land uses; 5) quantify nitrate attenuation in tributary streams and the main stem; and 6) integrate the results of these scientific investigations and make them accessible and useful to environmental managers and stakeholders.

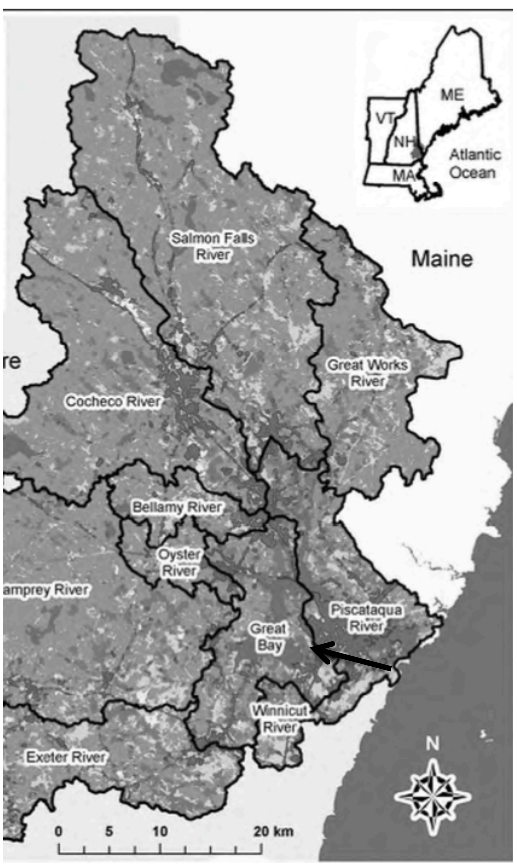

Figure 15: Map of the Great Bay Estuary (see arrow) and tributaries.

The initial project meeting involving diverse users took place January 7, 2011, at the University of New Hampshire in Durham, NH, and lasted approximately two hours. As with the ME project, investigators sought to integrate the initial meeting into a pre-existing event: in this case, a science symposium focused on one of the tributaries feeding the Great Bay Estuary. Approximately half the meeting occurred with the entire audience of the symposium (around 110 people). The second half of the project meeting occurred over the lunch hour and involved any participant from the larger meeting who was interested in the collaborative project. This ended up being between 15 and 20 people, not including the project team.

Table 23: Categories relating to Research Questions 2, 3 and 4 for the NH project.

Coding Category - Benefits	Case 5, NH
Builds understanding of project goals	3
More relevance	3
Strategy for communicating findings	2
Help to assess other users to invite	2
More legitimacy	1
Valuable info regarding natural resources	1
More credibility	1
Identify chances to leverage work	1
Coding Category – Project Distinctions	
More up front collaboration	2
User involvement more extensive	2
User input can alter research design	1
Collaboration is more explicit	1
Project accountable regarding collaboration	1
More disciplines involved	1
More scientist-based than user-based	1
Coding Category – Critical Elements	
Clearly describe roles & project design	4
Expand diversity of users	2
Focus on communication in/out of mtng	2
Ensure significant time for discussion	2
Provide well organized materials	2
Encourage prep work from participants	1
Hold meetings more frequently	1
Discuss if science can affect decisions	1

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11, two of the intended users as well as the lead biophysical scientist on the project gave the meeting the highest rating, while two intended users and the collaboration lead gave the meeting the next highest rating. Reasons for not giving the highest rating included, respectively: didn't get into the politics, which may be more important than the science; needed more diversity in terms of intended users; and didn't allow enough time to cover the agenda.

Research Questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 23 above indicates that eight benefits were noted by the interviewees, with four of them noted by multiple interviewees. With regard to Research Question 3—project distinctions—seven distinctions emerged from the qualitative analysis, with two distinctions—"More up front collaboration" and "User involvement more extensive"—noted by multiple interviewees. As noted earlier, like the MS project, this project's collaboration lead had a background in extension and noted that this project was more influenced by scientist notions of research needs than the usual extension model.

Regarding Research Question 4— critical elements of meetings that link science to decisions —eight elements were noted by interviewees, with five of them noted by multiple interviewees (Table 23). Compared with the other projects, the element "Clearly describe roles and project design" received lots of attention for this project meeting, with two of the intended users and both investigators noting that the project needed to be better framed. This most likely relates to the collaboration lead's own comment that there wasn't quite enough time to cover the project in its entirety. For example, one of the users noted: "I think it might be helpful to [provide] background materials to give people a little bit more about what's informing the project from the reports you're drawing on, or a bit more about the work you've already started on."

Direct observation: NH case I assigned this meeting a rating of "2." (See Figure 11.) In most respects, the meeting did not meet the Collaborative's expectations for clearly laying out the project goals and providing a clear pathway for intended users to contribute their knowledge to the research design. This could have been due to the unique challenges faced by this meeting, since it was a small part of a full day of science-related talks and discussions. As a result of the way the time was managed, the lunchtime meeting received less time, attention and focus than it would have had.

The direct observation notes indicate that relevance may have been enhanced by the meeting; the notes document between five and 10 instances of users asking questions or making comments, with the investigators responding. On the other hand, when compared with other projects, investigators seemed less consistent with regard to their interest in and commitment to incorporating user contributions. There were several instances when the collaboration lead had to quickly intervene and control the conversation because a different investigator had given a response to a user that may have been perceived as too curt or rigid in tone.

The above paragraph also aptly exemplifies the meeting's ability to enhance legitimacy. Again, at times there was a clear intent to be responsive to users, but there was also inconsistent execution of a legitimate process to create an even playing field for all participants. Credibility also was uneven, at least to my eyes. There were times when the investigators seemed in command of the subject matter but there were also times when the scientists contradicted each other. The direct observation notes document at least two instances where users asked questions and then didn't seem quite satisfied with the answer they received, based on their facial expressions and body language.

Note that there is nothing in the interviews to corroborate the author's views with regard to relevance, legitimacy and credibility. In fact, some of the interviews directly contradict the author's views on all three of these attributes. Table 23 shows that three people (two of them were intended users) saw relevance increase and one person (an intended user) thought both legitimacy and credibility increased.

Finally, it should be noted that, as with the case of the MS project, representatives from the Collaborative and project team members met to discuss potential differences in how the collaboration aspect of the proposal had been interpreted. Some discrepancies did come to light in these discussions. The project team also emphasized their particularly complex situation, in that their collaboration plan had originally been based on interacting with a large and pre-existing stakeholder group, with its own agenda that was not in concert with the goals of the project. As the project began, however, the project team decided that those efforts needed a new advisory group specific to the project. Recent progress reports and conversations between the program and the project team indicate that this new group—comprised of 15 planners, engineers, non-profit staffers and others—has been very active, meeting quarterly and contributing significantly to the direction of the project (NERRS Great Bay 2012).

Case 6: Impacts of Land Use and Stormwater Runoff on Water Quality for the Grand Strand, SC In the summer of 2004, anglers casting off South Carolina's Myrtle Beach (see Figure 16 below) were surprised to find themselves surrounded by flounder suffering from hypoxia. The flatfish were so plentiful and slow moving, observers could practically scoop them up with a net. For communities dependent on coastal tourism, this event was unexpected and troubling. Subsequent research has suggested that these events might be caused by land based sources like swashes—tidal creeks that traverse the local beach faces—funneling stormwater runoff and groundwater from a heavily developed landscape directly into coastal waters. Preliminary data indicates that land-based nutrients and organic matter are trapped in coastal waters by the regional influence of upwelling. Yet very little is known about how surface and ground waters mix and flow through swashes, or how they might transform the nutrients and organic matter passing through them into forms more likely to lead to hypoxia (Science Collaborative NI-WB 2012).

This project is addressing this knowledge gap by focusing on a sample of representative swashes along the Grand Strand to: 1) quantify terrestrial inputs of nutrients and organic matter associated with surface stormwater runoff and groundwater inputs under both dry weather and stormflow conditions; 2) establish the link between terrestrial nutrient loading under contrasting flow conditions and the net organic matter production occurring within swashes; and 3) determine the subsequent net tidal export of material (magnitude and forms) from these swashes.

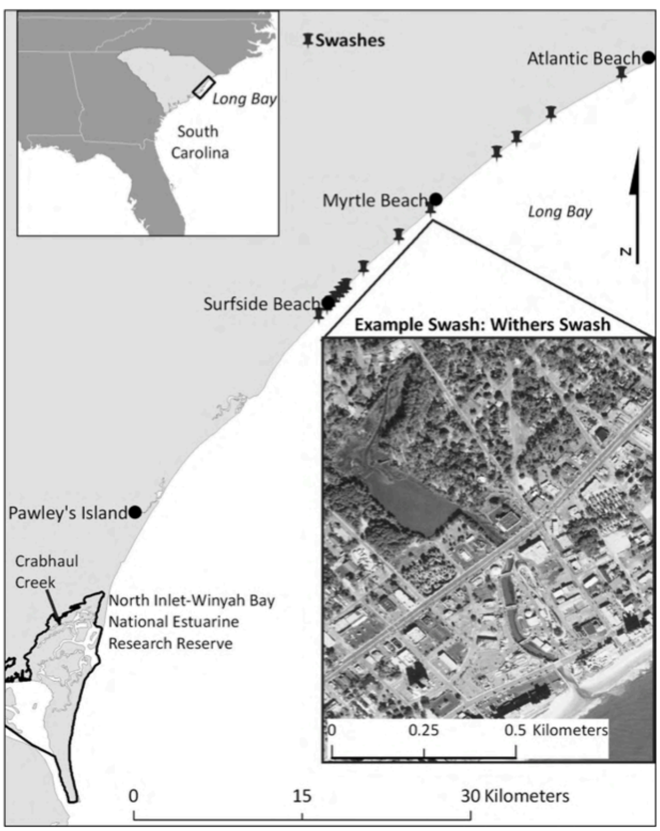

Figure 16: Map of the project study area along the South Carolina coast.

The initial project meeting involving diverse users took place November 30, 2010, at a public recreation center in Myrtle Beach, SC, and lasted three hours. Not including the project team, approximately 15 intended users attended the meeting, representing the engineering and planning departments of several towns along the Grand Strand, Horry County, state and federal agencies and scientists from Coastal Carolina University. The agenda pointed to a short list of objectives: 1) introductions, 2) bring people up to speed about the hypoxia events, 3) get input from users on the plans for the project and especially the task of creating a swash classification scheme.

Table 24: Categories relating to Research Questions 2, 3 and 4 for the SC project.

Coding Category - Benefits	Case 6, SC
More legitimacy	4
Builds understanding of project goals	3
More relevance	2
Builds awareness of project	2
Valuable info regarding natural resources	2
Generates enthusiasm for the project	2
Gets everyone on same page early	1
More credibility	1
Develop valuable relationships	1
Coding Category – Project Distinctions	
User input can alter research design	4
More up front collaboration	3
User involvement more extensive	3
More disciplines involved	1
Coding Category – Critical Elements	
Ensure significant time for discussion	3
Expand diversity of users	2
More user participation, less listening	2
Focus on communication in/out of mtng	1
Provide well organized materials	1
Have a good facilitator	1

Research Question 1: Contribution of Meetings to Project Linking Science to Decisions As shown in Figure 11, three of the intended users gave the meeting the highest rating, while the lead ecologist, the collaboration lead and one of the intended users gave the meeting the next highest rating. Reasons for not giving the highest rating included, respectively: was hoping to have more time to discuss sampling plan details; hesitant to give highest rating as it implies one can't do better; and could have used more stakeholders and more opportunities to give input.

Research questions 2 through 4 Regarding Research Question 2—meeting benefits—Table 24 above indicates that nine benefits were noted by the interviewees, with five of them noted by multiple interviewees. Notably, four out of six interviewees (three intended users and one investigator) thought the meeting enhanced legitimacy. The following quotation from an intended user on the project clearly shows his appreciation for how his feedback has been incorporated into the effort: "Typically, we'll have more one-on-one type of meetings with the researchers and get feedback done that way, whereas this project, it's done more as a group, which to me works a bit better, in terms of being open…to all the communities, not necessarily just the communities where the research is being done." In addition, this was the only project where two of the interviewees—in this case, the investigators—noted that the meeting seemed to generate enthusiasm for the research.

With regard to Research Question 3—project distinctions—four distinctions emerged from the qualitative analysis, with three distinctions—"User input can alter research design," "More up front collaboration" and "User involvement more extensive"—noted by multiple interviewees. The thoughts of the lead ecologist on this aspect of the project are especially interesting: "Of course, I've worked on other research projects that have had an applied angle, and I've had interactions with intended users and decision makers, but it's never been this type of up-front interaction. Certainly, I've never verbally given anyone the option to second guess my proposed sampling scheme/strategies or objectives like I did today."

Regarding Research Question 4— critical elements of meetings that link science to decisions —six elements were noted by interviewees (Table 24), with three of them noted by multiple interviewees (“ensure significant time for discussion,” “expand diversity of users,” and “more user participation, less listening). There seemed to be agreement that the meeting ended just as the conversation reached its peak in interest and interactivity, as the investigators asked for input from the users on which swashes to sample and how often.

Direct observation: SC case I assigned this meeting a rating of “4.” (See Figure 11.) In particular, the author noted at least 29 instances where the perceived relevancy of the project was potentially improved. The meeting provided many examples to choose from. Perhaps the best example came when a user pointed to the slide with a list of candidate swashes to study and noted that an important swash was missing. Both investigators were surprised by this as were many other users in the room. A vigorous discussion ensured and the swash was added to the list.

Legitimacy was potentially increased by the meeting. Although several people noted that they wanted more time to discuss the details, it was very evident from the structure of the meeting that the intent was to involve the users as equals. (If this didn’t come to fruition, it was more a matter of facilitation and time management than intent.) Secondly, the tone of the meeting was very deferential to the users. As noted by the lead ecologist in the quotation offered above, he explicitly asked for comment on the research design and seemed amenable to suggestions for improvement.

Finally, evidence suggests that credibility was enhanced as well. In contrast with some of the other projects, a significant proportion of the meeting was spent going over technical matter. The direct observation notes indicate that the presenter’s answers to questions were met with nods of appreciation as opposed to frowns or looks of skepticism.

With regard to potential improvements, the direct observation notes reflect a concern with staying on time in accordance with the agenda. The notes do suggest one fairly simple improvement that could have led to even more relevance and legitimacy. The investigators may want to have more explicit points, especially in the midst of long, technical presentations, to pause and remind users how this is thought to be relevant and to ask for comment from the participants.

Cross-Case Analysis for Research Question 1: To What Extent Did the Meetings Contribute to the Ability of the Project to Link Science to Decisions? Based on the interviews of the project team members and the intended users, all six meetings contributed to the goal of linking science to decisions. Figure 11 (beginning of "Results" section) shows that none of the 36 people interviewed gave a rating lower than "slightly contributed" which was the second best rating available. Interestingly, when people gave the meeting the highest rating, they did so with conviction. However, when they gave the meeting the second to highest rating, they often followed up with a caveat like "it's just too early to say" or "I never give anything the highest rating."

Interviewee ratings did not always correspond with the author's direct observation ratings. Note that the author gave two of the meetings (Case 2 and Case 5) a rating of "2"—with a few exceptions, meeting did not meet Collaborative expectations—yet interviewees rated those meetings similarly to the meetings that did match the Collaborative's expectations. See "Discussion" section for more on what these results might suggest.

Cross-Case Analysis for Research Question 2: What Benefits or Detriments Were Noted by Participants? Fourteen benefits emerged from the qualitative analysis (see Table 25 below). Only two benefits were noted by at least one person from all six projects: "more relevance" and "more legitimacy."

This quotation from an intended user on the AK project (Case 3) typifies feedback related to relevance: "I think the researchers got a lot of good information from the policy makers about not only their needs in terms of research, but helping them to think about what the implications are downstream and how this would be used, and what happens to a scientific document when it gets thrown into the political arena."

With regard to legitimacy, this quotation from an intended user on the NY project (Case 1) is a good illustration of how people see the meeting increasing perception of procedural fairness: "I can go back to my constituency and I can say, 'Ok. Here's what this means, and, yes, they did take this issue into account, and that's reflected here.' You end up having a much broader base of understanding and advocacy for the final product, whatever that ends up being."

Table 25: Categories relating to Research Question 2—the benefits of the meetings.

Coding Category	**# of people (n=36)**	Case 1, NY	Case 2, MS	Case 3, AK	Case4, ME	Case 5, NH	Case 6, SC
More relevance	17	5	2	3	2	3	2
Builds understanding of project goals	14	0	1	3	4	3	3
More legitimacy	13	2	2	2	1	1	4
Chance to exchange diverse views	13	4	3	4	0	2	0
Strategy for communicating findings	7	4	0	2	1	0	0
Helps to assess other users to invite	5	0	1	1	1	2	0
Builds awareness of project	4	0	2	0	0	0	2
Valuable info re natural resources	3	0	0	0	0	1	2
Generates enthusiasm for the project	2	0	0	0	0	0	2
Gets everyone on same page early	2	0	0	1	0	0	1
More credibility	2	0	0	0	0	1	1
Commonsense way to achieve goals	1	0	0	1	0	0	0
Develops valuable relationships	1	1	0	0	0	0	1
ID chances to leverage work	1	0	0	0	0	1	0

Categories were not decided on beforehand but rather emerged from the interviews. Numbers in the six rightmost columns refer to the number of people (n=6) that gave testimony attributed to a particular category.

No detriments were noted; however, some concerns and questions about the ramifications of the collaborative process did emerge, (i.e., these were relatively few and will be discussed in more detail as each case study is reviewed.)

Cross-Case Analysis for Research Question 3: What aspects of the projects were distinctive to participants, as compared with other projects seeking to link science to decisions? Thirteen distinctive aspects of the projects emerged from the qualitative analysis (see Table 26 below). Three distinctions were noted by at least one person from all six projects: "user involvement more extensive," "more up front collaboration," and "user input can alter research design."

Table 26: Categories relating to Research Question 3—the distinctive aspects of the project, as compared to other projects experienced.

Coding Category	**# of peop. (n=36)**	Case 1, NY	Case 2, MS	Case 3, AK	Case4, ME	Case 5, NH	Case 6, SC
User involvement more extensive	15	3	3	2	2	2	3
More up front collaboration	14	4	1	1	3	2	3
User input can alter research design	13	2	2	2	1	1	4
Collaboration is more explicit	7	2	1	3	0	1	0
More disciplines involved	4	0	0	1	1	1	1
Project accountable re collaboration	4	1	3	0	0	1	0
Collaboration is more structured	3	2	0	1	0	0	0
More scientist-based than user-based	2	0	1	0	0	1	0
Collaboration allocated more funds	2	0	0	2	0	0	0
Partnership with a Reserve	1	0	0	0	1	0	0
More likely to produce useful info	1	0	0	0	1	0	0
Collaboration is more academic	1	0	1	0	0	0	0
Collaboration is more process focused	1	0	1	0	0	0	0

Categories were not decided on beforehand but rather emerged from the interviews. Numbers in the six rightmost columns refer to the number of people (n=6) that gave testimony attributed to a particular category.

This quotation from an intended user on the NY project (Case 1) typifies feedback related to "user involvement more extensive: "Given my experience with charettes, public policy, outreach and whatever, this is the first time I've seen something like this trying to be attempted on this scale." Related to the distinction of "more up front collaboration," this quotation from an intended user on the NH project (Case 5) is illustrative: "I've been involved with or been the target of, if you want to call it that, a lot of outreach informing of what research has found, and that type of thing. But it's unusual to be at the beginning part of it or even expected that you're going to be coming back and getting information to feed into the project along the way."

Finally, with regard to "user input can alter research design," the following quotation from an intended user on the MS project (Case 2) is a good example: "The thing I found most interesting was the potential flexibility that the principal investigators have to tailor their plans according to the needs that arise during the project. Most of the work that I've done, it's pretty much set in stone, whether this is pure research, or even in terms of more applied situations."

Another result involves the distinction noted by the two collaboration leads from the MS project and the NH project: "more scientist-based than user-based." Both of these interviewees have a background in extension and had remarkably similar views about how this process—at this early stage—compared with their extension work. This quotation from the NH project collaboration lead sums the idea up well:

> For me, extension work is entirely driven by stakeholder need. That's what creates the question. Whereas this particular project...I think it's a combination of stakeholders and the scientists driving the question. I think the scientists intuitively know what some important questions pertaining to nitrogen and water quality are, but they also looked for overlap where their questions gelled with the broader stakeholders. So, my work is more stakeholder driven; that's the crux of it. Whereas this was driven more by scientists.

<u>Cross-Case Analysis for Research Question 4: What Critical Elements Should Meeting Designers Focus On In Order to Better Link Science to Decisions?</u> Nineteen critical elements emerged from the qualitative analysis (see Table 27 below). Two elements were noted by at least one person from all six projects: "expand diversity of users," and "ensure significant time for discussion." In terms of the number of people mentioning an element, the "diversity of users" was noted by the most people (21); "more user

participation, less listening," "focus on communication in/out of meeting" and "ensure significant time for discussion" were all noted by 11 different people.

It is important to note that this research question combines both positive and negative comments on meetings. In other words, using the "diversity of users" element as an example, interviewees often noted that they appreciated the diversity of users; almost as often, interviewees worried that the project team had left out some important constituents. Either comment would be categorized under "expand diversity of users."

Table 27: Categories relating to Research Question 4—the critical elements that project designers should focus on when designing interactions.

Coding Category	**# of people (n=36)**	Case 1, NY	Case 2, MS	Case 3, AK	Case 4, ME	Case 5, NH	C 6, SC
Expand diversity of users	21	4	5	3	5	2	2
More user participation, less listening	11	3	1	3	2	0	2
Focus on communication in/out of mtng	11	2	0	3	3	2	1
Ensure significant time for discussion	11	2	1	1	2	2	3
Provide well organized materials	5	1	0	0	1	2	1
Encourage prep work from participants	5	3	0	0	1	1	0
Clearly describe roles & project design	5	0	0	1	0	4	0
Have a good facilitator	3	1	1	0	0	0	1
Hold meetings more frequently	3	1	0	0	1	1	0
Discuss if science can affect decisions	2	0	0	0	1	1	0
Build project on previous relationships	2	0	0	0	2	0	0
Involve social science	2	1	0	0	1	0	0
Provide a record of meeting minutes	2	1	0	1	0	0	0
Ensure users see benefits to attending	1	0	0	0	1	0	0
Don't belabor the collaboration process	1	0	0	1	0	0	0
Choose a pleasant meeting location	1	0	0	1	0	0	0
Have different users host meeting	1	0	1	0	0	0	0
Strike a positive tone	1	0	0	1	0	0	0
Give users a chance to visit the field	1	0	1	0	0	0	0

Categories were not decided on beforehand but rather emerged from the interviews. Numbers in the six rightmost columns refer to the number of people (n=6) that gave testimony attributed to a particular category.

This quotation from an intended user on the NY project (Case 1) typifies feedback related to "expand diversity of users: "It would be helpful to have more broad-based participation, either in terms of percent of business interests or certain large users of utilities in the [Hudson River] valley, or maybe even the educational or environmental groups, so that there's that degree of overlap and lack of duplication of effort."

Related to the element of "more user participation, less listening," this quotation from an investigator on the MS project (Case 2) is illustrative: "The other thing that was pretty positive about [the meeting] is that we got the users to participate. It wasn't just the investigators talking about what they wanted to do; it was a dialogue, and I think that's important." This quotation from an investigator on the NY project expresses a similar notion but in the sense of suggesting some improvement: "In general, the thing I think we can do better is to get the advisors or participants to do more work and be more directly involved, instead of sort of being reactionary. They make good comments, but they're reactionary comments."

The element "focus on communication in/out of the meeting" actually comprises two related but potentially distinct ideas. The first idea is that the agenda should be structured so that investigators get input on how the broader community should be approached and communicated with once the findings become apparent. This quotation from an investigator on the SC project (Case 6) is indicative: "I think it was a good opportunity to engage the management community because often times, we just don't talk the same language…we just don't communicate as effectively as we should. So, today we made a good start down that path to engagement."

The other idea contained in the 11 comments within this category refer to how communication happens at the meeting itself. This is mostly related to the tone and length of the presentations, as in this quotation from an investigator on the NH project: "I would have probably, in the presentation about our project, tried to make the information a bit more accessible. I felt that the scientific information was aimed at the scientifically erudite. It probably was not something that would be readily graspable by the lay person."

Finally, the challenging notion of "ensure significant time for discussion" is well represented by this quotation from an investigator from the SC project: "In hindsight, perhaps one of the problems was too much time spend on delivery from me to them, but we felt that that was important given that we were bringing people on board that hadn't heard the hypoxia story before. Had we re-budgeted our time, maybe we would have gotten a bit farther in terms of getting [more input]."

Discussion

As noted in the introduction, the purpose of this study was to formatively—i.e., before the process is complete—assess the trajectory of six projects that were funded with the explicit intent of better linking science to decisions than the typical applied science project. Figure 9 laid out the Collaborative's notion that its RFP and review process would increase the amount of time, money and expertise allocated to linking science to decisions. This, the model postulated, would then result in a noticeable difference in the credibility, relevance and legitimacy (Cash et al 2003) of the projects, at least at this early stage; these attributes, in turn, have been shown to increase the extent to which science links to decisions.

So, have these unusual programmatic outputs had an impact on the trajectory of these six projects? Did the initial meetings contribute to better linking of science to decisions? (Research Question 1) What benefits or detriments have been seen? (Research Question 2.) How different is this approach? (Research Question 3) What elements should collaborative process designers emphasize to better link science to decisions? (Research Question 4). Below, I expand on the results section to clarify this study's findings in relation to these question. Then, I discuss the policy implications of the findings.

Clearly, the interviewees, taken either at the project by project level, or as a whole (see Figure 11) felt the meetings contributed to the goal of linking science to decisions. On a five-point scale, all 36 people interviewed rated the meetings they attended either at the 4 or 5 mark. This formative assessment requires special care as collaborative projects often begin with hope and optimism but can turn negative if people feel their time is not well used. (See the opinions of one of the intended users for the Oregon case study in Chapter 3, for example).

It is interesting and thought-provoking that, for two of the projects (MS and NH), concerns noted by the author's direct observation were only partially reflected in the interview comments and ratings. For the NH project, perceptions converged around problems regarding time management/preparation and logistics; for the MS project, perceptions converged around the lack of intended users. On the other hand, as noted in the results section, some interviewees nevertheless gave the meetings strong ratings and comments relating to credibility, relevance and legitimacy.

This author's view is that this is simply a function of a difference in standards and expectations. Having interviewed many collaborative process experts in the past—either for review panels or for research (e.g., Matso 2012)—and having read some participatory process literature (e.g., Daniels and Walker 2001; Roux et al 2006; Lynam et al 2007; Von Korff et al 2010), I have a particular vision of what can and should be accomplished in a collaborative meeting. This vision is in accord with the Collaborative's expectations as explained in the Methods section; meetings should involve a diverse set of intended users; be designed for bilateral creative input; and be facilitated so that everyone feels their input is valued.

In contrast, it seems that many of the interviewees were surprised and gratified simply by the intent of the projects to involve users to a greater extent. Therefore, they may have been less interested in quibbling about operational details. Moreover, it is possible that many people simply do not expect a high level of productivity from meetings, having experienced many unproductive meetings in the past.

Differences in expectations are also reflected by comparing results between investigators (n = 12) versus users (n = 24). This comparison was not planned originally and so does not appear in the "Results" section. However, the comparison results are relevant to the discussion of discrepant expectations. For example, Table 28 below may suggest that users, overall, were more attuned to both legitimacy and the importance of communications than the investigators. Likewise regarding project distinctions, Table 28 may suggest that users were more sensitive to early involvement in collaborations, increasing the extent of that involvement over all as well as the fact that user input could actually alter the course of the project. Finally, with regard to critical meeting elements, overall, users seemed to be quicker to note the importance of diverse user involvement, the importance of providing well organized materials and doing more to involve users even before the meeting. Due to the small sample size, all of these trends must be regarded as preliminary and warranting further research.

Table 28: Comparison of selected results between investigators and users.

Research Question 2: Benefits/Challenges	Invest. # of Proj.	Users # of Proj.
More legitimacy	3	6
Strategy for communicating findings	0	3
Research Question 3: Project Distinctions		
More up front collaboration	3	6
User involvement more extensive	3	6
User input can alter research design	3	6
Research Question 4: Critical Meeting Elements		
Expand diversity of users	3	6
Provide well organized materials	0	4
Encourage prep work from participants	0	3

Numbers in columns 2 and 3 shows the number of projects where one of the two investigators or one of the four users, respectively, gave feedback within the categories labeled in column 1. This table only shows categories where there was a difference of 3 or more between columns 2 and 3.

More compelling are the results involving the benefits/detriments of the meetings (research question 2) and the responses people gave when asked to compare this project, so far, to others they had been involved with. The four results (Table 25) that came up most in participant interviews were “more relevance,” “builds understanding of project goals,” “more legitimacy,” and “chance for interaction of diverse views.” If these projects do end up linking science to decisions, it does seem that the Cash et al model (2003) is at least partially (relevance and legitimacy) corroborated from these case studies. (I address the notable absence of “credibility” from the findings later in this section.)

More to the point, the interviewees, in general, seemed to indicate that the approach taken by these projects was unusual. At least one person in each of the six projects (Table 26) thought the project, so far, 1) demonstrated a more extensive involvement level with regard to intended users; 2) involved more up front collaboration; and 3) gave users an unusual ability to actually affect the course of the research, at this early stage. Furthermore, there is also evidence that there is a cause and effect relationship between the distinctive traits of these projects and the benefits noted, such as legitimacy. For example, within the 36 interviews, there were four “intersections” where an interviewee noted a comment involving “legitimacy” as well as one of the distinctive traits noted in Table 26. These quotations shown below (all from intended users), are explicit examples of distinctive aspects of these projects that directly increased legitimacy in the eyes of the user.

> (NY Project) I don't believe I've ever really participated in anything that is comparable to this in the past. Yes, our agency does sometimes have workshops and meeting groups but nothing that's gone to the extent that this project has to try to have broad-based support throughout the planning and inceptions stages, moving forward into demonstration projects and presumably some sort of conclusive report or guidance.

> (ME Project) First of all, we had a lot of the stakeholders here, the people who do the work in terms of the planning. One point I would make that’s very important, in my personal experience, is the lack of ownership in terms of the people you’re planning for or

with. We as professionals take ownership because that's what we do, but when we transfer that plan, it has to be owned by the people we are transferring it to, or they won't be willing to implement it.

> (NH Project) Highest rating. The people who presented and the discussion at lunch was presented in a way that showed they were very eager to find out who else they should be getting this information to...who else they should be communicating with. It is really important...communication is the most important thing and the fact that they were so motivated to hear from us who else they should contact and connect with was very inspiring.

> (SC Project) They really tried to make it a collaborative effort, which I really liked. I have dealt with researchers in the past, and it's one thing to take samples and have all these statistics and numbers, but it's a whole other thing to bring the local people, the lay people who are not part of the scientific community, into the decision making process and decide on what swashes might be best to use. For example, to take them out to the field and share my knowledge of the actual area to help them make it a better project.

This finding is important for funders seeking to better connect science to decisions, because it adds potentially important details to the more common admonitiion to simply increase opportunities for scientists and decision makers to interact (e.g., Pew Oceans Commission 2003; Urban Harbors Institute 2004; U.S. Commission on Ocean Policy; Donahue 2007; Dreelin 2008). Research Question 4, focusing on critical elements of those interactions, may also provide value to funders looking for more high-resolution advice on how to bring scientists and decision makers together in a productive format. This area has received relatively little attention outside the narrower disciplines of participatory research and community-based environmental decision making, although there are several exceptions to this rule (e.g., Jacobs 2002; NRC 2006; NRC 2009).

Table 27 compiles both negative and positive comments made by the interviewees into a list of critical elements to consider when planning interactions between scientists and users. Some of the elements that turned up most often are simple intellectually, but are difficult to actualize. For example, "focus on communication in/out of the meeting" involves a reminder to discuss how findings should be presented at the end of the project. It also, however, involves the lesson learned by half the collaboration leads, that they need to invest more time in working with presenters of technical data to ensure the presentation is of the appropriate tone and length as well as clearly understandable.

"Ensure significant time for discussion" (Table 27) is a similarly uncomplicated admonition. Nevertheless, it deserves attention since it arose fairly consistently as a criticism in these six projects. Why? It is difficult to say. One reason may because of the culture of scientific presentations at technical conferences and the like. The standard format, unsatisfying to many yet it continues as the main conference approach, is for people to present in a unilateral way for 15 minutes and then have a question-answer period for five minutes.

In contrast with the elements just discussed, the top two items on the list—"expand diversity of users" and "more user participation, less listening"—may have required a level of craft or experience that was more challenging for the collaboration leads of these six projects. This has important implications for funders determined to increase the effective linking of science to decisions.

The element of "more user participation, less listening" again emphasizes the need to break out of the all too common forum of scientists talking at people and then asking for questions. A common method for dealing with this problem is introducing breakout groups to the meeting structure. While this has positive aspects, it is notable that none of the six projects employed this technique: most likely, because there was a need to bring people up to speed, and breakout groups may have made this logistically difficult and inefficient. Still, in the absence of breakout groups, there are many techniques and strategies for getting more creative input from users. For example, the Collaborative Learning model (Daniels and Walker 2001) has several examples of ways to increase participation from users. In addition, peer-reviewed journals such as *Ecology and Society* often publish reviews of public participation techniques (e.g., Lynam et al 2007) that are accessible and appropriate for fostering engaged/two-way communication. The International Association of Public Participation supports the advancement of participatory process in the United States as well as other nations. Finally, there are have been many publications that delve into the rationale for participatory processes (e.g., Webler and Tuler 2001; Burgess and Chilvers 2006; von Korff et al 2010), which can also be helpful in the design of engagement strategies.

The issue of involving a diverse number of intended users was clearly an important issue with these six projects (Table 27). All six projects had at least one example of someone noting a missing consituency that was critical to actualizing the project's goals. In some cases, such as with the AK, MS and ME projects, the investigators suggested that their approach was planned, from the outset, to slowly grow in terms of numbers of constituencies. In the other cases, this wasn't as clear. While there are some resources for guiding the identification and convening of stakeholders (e.g., Susskind 1999; Daniels and Walker 2001; Clark 2002; Von Korff et al 2010), it wasn't clear from the interviews if these resources had been consulted as part of these projects.

This marks an area that requires additional research. The Collaborative has made some assumptions that a participatory process will use a clear rationale for engaging diverse representatives of society at large. One question that requires more research is whether these projects are or will involve a diverse enough representation of intended users, or if, on the other hand, they are simply serving an elite or familiar group of users. A second area of inquiry is to follow how a diverse sub-sample of a given intended user population that disseminates—or doesn't—new knowledge to others who weren't actual participants in the project. For example, Hanna (2000) tracked participation effects beyond direct meeting attendees and documented that information was often transformed (and not always in useful ways) when the meeting participants communicated about the meeting to their colleagues who were not in attendance.

Conclusions

The value of the case study methodology is that it often produces rich enough data that the researcher can conclusively state that, in this case, a particular phenomena did or did not occur. It is up to future studies to conduct similar case studies in similar contexts to begin to build a sense of how common the finding might be across society.

For these case studies, we can say conclusively that, for many of the participants, these projects were proceeding in a manner distinct from their previous experiences with linking science to decisions. Some of the participants directly connected this distinctiveness to specific benefits, including increased relevance and legitimacy. We can also say with certainty that even projects that received mostly praise also could have been improved by, for instance, including more users or thinking more creatively about getting contributions from users in attendance.

Funders interested in acting on these results find themselves in the same quandary as many natural resource managers, attempting to make decisions with incomplete information. These projects have just started; who knows if they will continue on this trajectory and if they will, indeed, lead to better linking of science to decisions? Making decisions in a context of uncertainty necessitates a careful examination of the potential benefits and liabilities and other operational complexities. Let us discuss potential benefits and liabilities first.

Based on these results, what is the downside of this approach that seeks to change the RFP and the review process in order to direct more attention and resources to linking science to decisions? For these projects, which have just begun, the main downside is that it may impact the speed at which science generation occurs, because time and resources are now being allocated to collaborative efforts. This finding has been reported earlier to the author by those with experience in participatory processes (e.g., Chapter 3 of this work; Gregory et al 2012). Participatory processes take time. In a zero-sum game, that means a slow down for the generation of new science. This only becomes worth it if the generated information is significantly more credible, relevant and legitimate.

It is difficult to assess how the other misgivings reported by the interviewees should affect a funder's decision to change the way it funds science. Overall, misgivings were few. Some misgivings involved the fact that it was early and people were frankly unsure how much this would help. On the other hand, no one thought that this process would hurt the prospects for linking science to decisions. The worst result, by implication, is that it might not be worth the effort to focus so much on collaboration. Other misgivings may actually suggest an increase in collaboration, not a decrease. For example, two people (from two different projects) questioned the notion that science would actually impact decisions, especially if the issues of politics were not tackled head on (Table 27, category: "Discuss if science can affect decisions").

Finally, there was no evidence to support the fear of some scientists that opening up their research design process to the lay audience would decrease the credibility of the science. If anything, the opposite was seen: for example, in the SC case where intended users improved the list of swashes to be sampled. A similar result was reported by Beierle and Cayford (2002), where the authors found that participatory processes, overall, were seen as improving the quality of the science, not compromising it.

On a related note, the author has observed---from direct comments as well as extrapolation—that collaboration may change the focus of the research so that it ends up being less innovative and groundbreaking and, perhaps, less publishable in certain journals. However, this is different from saying that the science becomes less "credible." Nevertheless, it is a concern as publishing in journals is an important aspect of the incentive structure for many scientists.

At this point, let us assume that the reader is a funder who believes that their program may need to change the way it funds research in order to emulate some of the benefits and distinctions noted in this study. How does one go about making the necessary changes to actualilze those goals? Based on the Collaborative's experience, this can be a very challenging task.

Based on feedback from applicants, peer reviewers and panelists—some of which is detailed in Matso (2012)—it is the Collaborative's view that it made some key mistakes in the implementation of this RFP. Most importantly, the review process did not reflect the integration and balance between science generation and science linking that was articulated in the RFP. On the positive side, the Program did solicit balanced feedback from the peer reviewers; each proposal was reviewed by two reviewers focused on the applied science problem (e.g., salt marsh restoration; better understanding institutional barriers to enacting climate change regulation) and two reviewers focused on participatory processes. But the panel was not similarly balanced. In the Program's view, this panel did not have the requisite pariticipatory process knowledge to recognize proposal weaknesses and to suggest improvements where necessary.

In the subsequent two years, the Program made several important changes (see next paragraph) that any funder should also consider, should they want to consider a similar strategy. The assertion that these changes have led to improvements are based on comments from both applicants and panelists as well as the Program's observations; some applicants and panelists have participated in all three review processes, so their feedback is quite credible.

First change: the Collaborative no longer uses "write-in" peer reviewers. We have decided that this kind of transdisciplinary science—meaning that it integrates different science disciplines and involves stakeholders—is complicated enough that all reviewers should sign on to the entire review process, and not just participate in one aspect of it. Moreover, all reviewers need to have the opportunity to share their perspectives with others who may see the problem differently. This change reduces the tendency for some reviewers to exclusively focus on their expertise and ignore what the Program is trying to do more holistically.

Second change: the Collaborative now operates a completely balanced review process: the review panel is balanced 50/50 in terms of emphasis on science generation versus science linking. As the reader will see in Chapter 5, this is a controversial approach, even amongst programs that are in agreement about the importance of improving on the traditional applied science model. However, the Collaborative has seen firsthand, through panel processes, that an unbalanced review panel will lead to the funding of proposals that are similarly unbalanced in terms of the detailed nature of their methods and the distribution of monetary and human resources.

Third change: save Program staff time to educate applicants and the reviewers, at every stage of the process, about the implication of participatory processes, and how these processes MUST change the nature of the research project itself. The clearest example of this involves the issue of flexibility within the project. Involving users in more than a token manner—that is, allowing them to change the course of the research after the award—necessitates that two things happen that are very challenging. First, the applicant team must write a proposal that demonstrates multiple opportunities and mechanisms for the users to modify the research. Second, within that flexible framework, applicants still need to show the reviewers that they are technically capable of implementing the science, even though everyone knows the science may change.

The fact of the matter is that very few people, in our experience, have written proposals that fit this profile. At the same time, we have noticed that applicants can modify their understanding of research proposals—and can even become enthusiastic about it—if sufficient time is given to talking about the challenges and potential benefits of conducting research in this manner.

In conclusion, let me emphasize that this is an iterative process that requires experimentation and experience, for program managers, scientists, communicators and intended users. Linking science to decisions involves concepts that are confusing and further jumbled by diverse assumptions about knowledge and policy and the role of science in society. Because of this complexity, conversations that occur in the abstract can only get one so far; in the worst cases, the conversations can be frustrating and unproductive. We have seen these conversations become much more constructive after project teams have tested a more comprehensive involvement of intended users and participatory processes for themselves, creating a common foundation of experience from which to draw in the future.

CHAPTER 5

THE DEVILISH DETAILS: WHAT SPECIFIC ACTIONS SHOULD FUNDERS TAKE TO BETTER LINK ENVIRONMENTAL SCIENCE WITH DECISIONS?

Introduction

Most coastal areas struggle with a plethora of complex problems, many of them satisfying the definition of "wicked" problems as coined by Rittel and Webber (1973). For example, Rittel and Webber point out that, with wicked problems, problem formulation itself is can be a matter of debate. Also, it is usually not clear when the problem is actually "solved;" rather, society can only endeavor to manage the problem.

Issues facing coastal communities—such as overdevelopment, non-point source pollution, flooding, shoreline erosion, invasive species, etc.—certainly qualify as wicked problems. The role of science in solving such problems must be carefully considered. Tradeoffs are a fact of life, which in turn necessitates considerations of choices about values and tolerances for risk.

Numerous reports and studies have indicated that, in the United States at least, many investments in science are made with a goal of directly addressing wicked problems. However, the overall record on resulting new knowledge actually being taken up and used by society to address these tough problems leaves significant room for improvement (e.g., National Research Council 1995; Pew Oceans Commission 2003; United States Commission on Ocean Policy 2004; Urban Harbors Institute 2004; Rayner et al 2005; Riley et al 2011). For example, Meyer (2011) notes that the US has invested over 30 billion dollars in climate science over the last 20 years. For those investments to better link with societal actions, Meyer concludes that science sponsors need to employ a more strategic and nuanced approach to ensure that the results of these investigations are accessible to society.

Following Meyer's line of thinking, this study targets funders of science as a key community capable of creating change in how science is implemented to address problems in a "timely" fashion. The inclusion of the word "timely" is critical as it places this study in a specific context. It is important to clarify early my belief that our society requires a diverse portfolio of scientific investments. Many of those investments should and will be made with the hope of simply increasing knowledge for the sake of more knowledge itself. These investments can have enormous impacts on our lives. On the other hand, this study concerns that part of the science portfolio where science is commissioned for the express purpose of solving pressing problems in a timely manner, where funders hope that the science will contribute to society within several years of the project's conclusion, if not even earlier.

Meyer, noted above, is not the only one who thinks that funders have a disproportionate impact on the issue of better linking science to decisions. In 2006, the National Research Council (2006) released a report that focused on the role of the program manager in better linking science with decisions. The report was stimulated by repeated evidence that funding program managers were key determinants of whether science linked to decisions or not (NRC 2006). This report, like other reports on the subject of creating more "useable" science (e.g., Dilling et al 2010), tends to offer important but nevertheless fairly general recommendations on what funders should do to better link science with decisions. (To be fair, the NRC report does offer many case studies in its appendices that do provide some detailed practices for funders to consider.) For example, a laudable but fairly general recommendation in NRC 2006 is to seek dialogue and cooperation between scientists and the users of the science. The excellent report, “Informing Decisions in a Changing Climate,” (NRC 2009) recommends that program managers prioritize process over products. This is another example of an important principle that nevertheless leaves the program manager with an abundance of discretion in terms of how to fulfill the objective. The goal of this study, which builds on the earlier chapters in this dissertation, is to bring the discussion to a finer resolution scale and begin to present different specific options and actions that confront program managers who want to better link science with decisions.

For the purposes of this work, I define “science” as a systematic effort to acquire reliable knowledge about the world. This definition is based on Jared Diamond’s conception, as related in his book, “Collapse: How Societies Choose to Fail or Succeed” (Diamond 2005). I use the term “decisions” in a general way, referring to a suite of possible activities, from the choices citizens make about their property to the decisions made by professionals in the environmental field to choices made fishermen and volunteer land use planners. Finally, I use the term “linking” to suggest that point at which exposure to information or a tool alters one’s beliefs about a problem or decision. This is adapted from the Consultative Group on International Agricultural Research (CGIAR) Science Council’s (2006) conception of the “impact pathway” of research.

This is achieved by using the results of Chapters 2, 3 and 4 as the source material for fashioning a set of objectives and best practices and then gathering a small community of science funders to comment on these suggested protocols via a combination of survey and focus group instruments. I use the term “objective” here in its standard sense, referring to some desired state or achievement. The term “best practice” denotes some means that is accepted by a segment of society (e.g., relevant professionals) as a superior or effective way to achieve a given objective.

Background

With my colleagues, I have been experimenting with different ways of using competitive grants to link science with decisions, first as part of the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)—this program's last RFP was issued in 2009—and currently as part of the NERRS Science Collaborative (or "the Collaborative"). Both of these programs are a partnership between the Estuarine Reserves Division of the National Oceanic Atmospheric Administration (NOAA) and the University of New Hampshire. My previous chapters as well as two publications (Riley et al 2011; Matso 2012) have documented efforts to understand if these experiments have led to expected outcomes and to understand the main factors determining whether science does link to decisions.

My previous chapters used a multiple case study approach, interviews with investigators as well as intended users as well as some direct observation, to explore what funders could do to better link science with decisions. The two most salient objectives to emerge from those studies were: 1) Scientists and users must work together more frequently before and during the project. The "before" term is particularly important as it addresses the problem of scientific research that provides good answers to questions that lack relevance to intended users; 2) Interactions between scientists and users have to be better designed and executed. Taken together, there is, therefore, a call for an increase in both the quantity *and* quality of scientist-user interactions.

Drawing on these findings, I created a set of objectives and "best practices" to specifically address those findings (see Table 29). It should be noted that while all six objectives were explicitly suggested by multiple interviewees, only some of the best

Table 29: Suggested objectives and best practices—some explicitly suggested and other extrapolated—derived from Chapters 2, 3, and 4 as well as Matso (2012). Best practices are placed within the same row as the objectives they are meant to affect.

Objectives	Best Practices
1) Ensure that the project has appropriate personnel, requisite methods and adequate resources (time, money) to best link science to decisions.	1) Funders request same level of rigor for science linking methods as for science generation methods; & funders are clear that both are a priority. 2) Funders ensure that they find and use experts in science linking (e.g., participatory process experts) to review relevant components of the proposal. Ideally, there should be as many science linking reviewers as science generation reviewers. 3) Funders ensure that different kinds of reviewers can interact & learn from each other via the review process.
2) Ensure that research proposal reflects significant user input on a) what is highest priority research needed, b) the specific framing of the problem and c) the specific framing of the research approach to address the problem.	4) Funders should use RFP to define & raise minimum extent to which investigators and users need to work together to frame the problem and agree on a research approach, either during proposal development or as part of the project itself. 5) To accommodate project teams that have not had the time to collaboratively frame the problem and research approach, funders need to provide a mechanism to offer financial support for this activity. This can be done by either a) allowing needs assessment research within the main grant competition, or b) by offering a separate competition for this purpose.
3) Ensure that project structure reflects iterative learning and adaptability.	6) Require or encourage proposals to include at least two iteration loops (i.e., a pilot study) within the research project. Each iteration should include: needs assessment, research design, research implementation, and linking of results to decisions. Each iteration should be followed by an assessment of appropriate changes for future iterations.
4) Ensure that distribution of power within the project team reflects the goal of linking science with decisions, not just generation of new science. **Practices 7 & 8 are actually alternatives to each other. Note that some participants felt the connection between these best practices and Objective 4 was weak & should be changed.*	7) Funders should use the RFP and the award contract—as well as a post-award verbal communication—to make clear that the person in charge of linking science with decisions has dual accountability: to the project team and to the funders. (This is similar but distinct from the Principal Investigator or Project Coordinator role, which is accountable to the funder for the general administration of the project.) *8) Funders use the RFP and the award contract to clarify that all projects will have a partnership management structure, with one component of the partnership represented by an investigator from the project team and the other component represented by a staff person from the funding organization.
5) Ensure that project team is held accountable to the funders and the intent of the RFP.	9) As part of the award process, funders should develop process-based metrics with the applicant team and tie continued funding to the team's ability to meet expectations.
6) Increase commitment to working with applicants throughout the review process and project implementation to clarify this approach to better linking science with decisions.	10) If funder does not have someone on staff with the time and significant experience linking science with decisions, the funder should contract with such a person to help oversee these aspects of the funding process throughout all stages of the competition and project implementation.

practices came directly from interviews. Other best practices were extrapolated by the author based on his particular understanding of the tools available to funders, of which non-funders may not be aware. For example, Best Practice 4 (see Table 29) was suggested several times in interviews, as in this example from Chapter 3: “It [should] be a requirement of the RFP process to somehow prove that the people who may actually use the science in an applied way were part of the proposal team that replied to the RFP.”

In contrast, Best Practice 2—“Funders ensure that they find and use experts in science linking (e.g., participatory process experts) to review relevant components of the proposal” (see Table 29)—was an extrapolation as logical means for achieving Objective 1. Having heard many interviewees note the difficulty of managing interactions between scientists and users, and having heard many note the importance of making knowledge dissemination as important as knowledge generation, I extrapolated that this balance should be reflected in the proposal review process. At the time of this writing--Spring, 2012—I have also presided over two review processes using this technique and have been told explicitly by the panelists that this approach is unusual and overdue. In addition, preliminary evidence from awarded projects suggests that this review process approach produces tangible benefits to the project. So, while it is an extrapolation, it has its basis in empirical experience.

In order to get additional input on these objectives and best practices, I convened a group of funders to weigh in on these guidance suggestions. Why did I want additional input? Of course, there are things I have learned from my experiences with CICEET and the Collaborative that are relatively unshakeable; for example, no matter what another funding program manager says, I will continue to believe in the importance of balancing knowledge dissemination and knowledge generation. However, I was genuinely curious if other funders were experiencing similar successes and challenges when they tried to better link science with decisions. Also, while I believe the Collaborative does use some innovative and successful techniques, I am very much aware that there are other ideas that other programs are implementing that could improve the way we—as the Collaborative and more broadly, as a society—link science to decisions.

Methods

The following research questions guided this study: 1) To what extent did the six objectives (see Table 29) capture the concerns of the nine participant programs? 2) Of the six objectives, which objectives were viewed as most important? 3) What best practices, based on the focus group's feedback, emerged as most likely to effectively link science to decisions? In addition, it was an explicit goal of this study capture important ideas that might transcend these defined questions, with the caveat that they have a direct bearing on how funders can better link science to decisions.

Analytical Framework For this dissertation, the primary mode of analysis is qualitative. Qualitative methods normally emphasize a mode of inquiry that does not pre-suppose specific relationships between sets of variables associated with the phenomenon of interest (Yin 2003). Often, the approach can be open, flexible and iterative, allowing the researcher to note patterns and then return again to the data to strengthen emerging explanations that account for multiple and diverse perspectives. Frequently, though not always, qualitative methods are used in an inductive mode—that is, in the process of studying small numbers of phenomena in order to build a theory—as opposed to a deductive mode, where many repetitions are used to test a specified theory or hypothesis.

Interviewee Selection The core of this study is founded on the premise that we can do better, as funders and as a society, in linking science to decisions. Therefore, it was important to invite participants who agreed with this premise. If I broadened the focus group to include people who do not agree with this premise, the group would have had considerably less time to discuss the objectives and the best practices. Additionally, I sought people who had experiences trying new methods for linking science to decisions: the rationale being that their perspectives would be more valuable if they were founded on experiences rather than hypothetical abstractions. The participants shown in Table 30 below all satisfy these criteria.

Table 30: Programs participating in the focus group. Program representative backgrounds are also shown.

Program	# of Reps	Rep 1 Original Training	Rep 2 Original Training
Climate Program, NOAA	1	Physical science	n/a
Center for Sponsored Coastal Ocean Research, NOAA	2	Ecology	Ecology
Coastal Services Center, NOAA	1	Education	n/a
Sea Grant National Program, NOAA	1	Marine biology	n/a
Michigan Sea Grant, NOAA and State of Michigan	2	Science-Policy Intersection	Ecology
The Graham Environmental Sustainability Institute	1	Ecology	n/a
Maine Sustainability Solutions Initiative, funded by the National Science Foundation (NSF)	1	Ecology	n/a
National Socio-Environmental Synthesis Center, funded by NSF	1	Economics	n/a
The California Ocean Science Trust	2	Ecology	Science-Policy Intersection
The Switzer Foundation	1	Ecology	n/a

***"n/a" indicates that there was only one representative for that organization.**
**** Note that a representative from the National Science Foundation's Dynamics of Coupled Natural and Human Systems intended to participate in the focus group but was unable to complete the activities due to last-minute work-related issues.**

Yet it would have been possible to satisfy these criteria and come up with a completely different set of participants. Why were these particular programs chosen? Several of the programs were named in an earlier study (Matso 2012), when peer reviewers were asked to name programs that excelled at effectively integrating natural and social science to solve problems. Other programs were included through a mixture of “snowball” and “opportunistic” sampling (Patton 1990). Some notable programs were invited but were unable to attend due to scheduling conflicts.

Data Collection and Analysis The focus group format was chosen because of three benefits associated with it: 1) Focus groups provide an efficient means to gather information from multiple sources simultaneously; 2) focus groups allow for discoveries that are not constrained by the researcher’s view of the situation; and 3) focus groups provide a forum for mutual learning, dissemination of information (Stewart and Shamdasani 1990).

Originally planned as face-to-face focus group, it was necessary to switch to a virtual format when some of the participants were unable to travel due to budget constraints. To avoid overburdening the three-hour virtual web conference with too many questions, some of the questions were assigned up front via a short survey delivered via Survey Monkey. This had the added benefit of ensuring that the participants had all read the same preparatory material and were proceeding, as much as possible, from a similar foundation of assumptions.

The preparatory materials consisted of one 10-page document (see Appendix G) that reviewed the highlights of Matso (2012) and Chapters 2 through 4, as well as some unpublished observations. This document also included the objectives and best practices shown in Table 29. Participants were asked to read the document and then fill out the survey (see Appendix F) as well as articulate some key perspectives. This included: naming three of the six objectives they felt were most important; then, naming the one objective that was most critical to linking science to decisions; and for those three objectives they selected, rate the associated best practices under those objectives on a four-point scale (strongly agree, agree, disagree, strongly disagree). Participants were also asked to add any objectives and/or best practices they thought were missing.

The focus group was implemented via web conference on May 30th, 2012 and was facilitated by the author. The entire three-hour event was recorded using Garage Band software on a MacBook Pro computer. These electronic files were then exported to NVIVO 9.0, a qualitative research analysis software package that facilitates the transcription, organization and analysis of qualitative data. For this analysis, NVIVO was used to help "code" responses. The term "code" simply refers to the placing of parts of the interview (e.g., sentences, paragraphs, etc.) into labeled categories in terms of how they relate to the research questions.

Based on my research questions, I created a coding framework to hold the categories that would emerge from the analysis. This framework included three "parent categories" for all the input regarding each objective and each best practice: 1) comments in support of the objective; 2) comments against the objective; and 3) clarifications. In addition, I created a parent category labeled "other" for any thoughts pertaining to linking science and decisions, where were not direct comments on the objectives or best practices. Below, I offer some examples of how categories arise from the feedback.

In one instance, a participant chose Objective 1 (focused on methods, see Table 1), noting that: "the goal of more effectively linking science to decisions can only be achieved with appropriate personnel, proper methods, and adequate resources." This suggests the participant sees Objective 1 as more of a pre-requisite to linking science to decisions than the other objectives. A category labeled "pre-requisite"—under the parent category of "comments in support of the objective"—was then created to capture similar notions from other participants.

The parent category “other” became a repository for a range of ideas relating to linking science to decisions. Some of these ideas ended up being mentioned only once. For example, only one person noted the importance of being able to cut off funding to awardees that don’t perform well (see Table 34 in “Results” section). On the other hand, six of the 10 programs warned against being too rigid and formulaic in the application of best practices. As the reader will see in Table 34, I tried to further bin the categories to reflect that the comments are addressing different scales.

According to Stewart and Shamdasani (1990), this kind of content analysis can be referred to as “designation analysis;” the goal is delineate those concepts that arise from the data, count how often they occur, and connect to the testimony of different participants. While not mathematically or statistically complex, this kind of analysis can be challenging; it can be difficult to find and choose boundaries between comments that effectively show the distinctions and similarities between ideas.

In the Results section, I will focus on those explanations that arise from as many perspectives as possible, explain the most about the phenomenon and demonstrate the most internal consistency (Strauss and Corbin 1990; Charmaz 2006). By “internal consistency,” I mean that an idea does not directly contradict a separate idea that seems to have validity, based on the interview feedback. The reader will see in the tables presented in the Results section that there are some ideas that are in direct conflict with each other. All ideas are included in the tables, but the text and the discussion focus on those that are most prevalent and most salient.

With this focus on the ideas that emerge most often, am I suggesting that the ideas mentioned by fewer people have less validity? I am not. However, in the final analysis, funders need to target those ideas that have the highest likelihood of being relevant. Also, with regard to linking science to decisions, perceptions of what is true—whether true or not—are worthy of consideration. Science links to decisions through people, and people's perceptions are what provide and remove opportunities for linking. Therefore, if an idea seems to be held by multiple people across multiple case studies, I assert that it may warrant more attention from funders.

Caveats Related to the Methods It is important to point out that I worked for the two research programs that served as the subjects for the evaluative work in Matso (2012) and Chapters 2, 3 and 4 of this thesis. Some may believe this disqualifies this research as being "subjective." However, within qualitative methods such as "grounded theory" (Strauss and Corbin 1990) as well as other policy sciences disciplines such as action research (O'Brien 1998), ethnography (Yin 2003) and natural resources policy studies (e.g., Clark 2002), the researcher can both study and be a change agent in the context of the study. In grounded theory, the specialized knowledge of the researcher is referred to as "theoretical sensitivity" and this is brought to bear to improve explanations for the observed phenomena. In my case, as a program manager by profession, I have an advantage in taking various kinds of feedback and translating that feedback into options for other program managers. At the same time, I have to be transparent about my biases, which have the potential to distort the explanations.

In this case, my bias, based on my own personal orientation towards natural and social sciences, is that many applied science funding programs under-emphasize the human dimension aspect of natural resource problems. In my view, this is mostly done due to convention and the history of science and technology policy in this country, which has put much more emphasis on generating new knowledge and much less emphasis on diffusing that knowledge (Tornatzky and Fleischer 1990; Stoneman 2002; NRC 2006).

Finally, I should emphasize that this focus group is in essence a meta-analysis in that I have asked a group of funding program managers to reflect on the lessons learned from their own experiences. This in turn introduces the individual biases of these particular program managers as they interpret the successes and failures of an entirely different set of projects than the ones I have studied in the previous chapters.

Results

In reviewing the study results, I will first present the most salient results related to the three research questions. Then, I will present several important ideas that emerged from the focus group that were relevant to the key concern of linking science to decisions, but were outside the scope of the proffered Objectives and Best Practices.

Research Question 1: To what extent did the six objectives capture the concerns of the nine participant programs? Although the programs had the opportunity in the survey to add additional objectives, only two of the 10 programs did so. One program noted that "funders should be accountable to the project team," which is a reversal of Objective 5. This suggested objective also overlaps with Objective 6, which deals with offering more program support to project teams (Table 29). The other suggested objective was that "Funders should clarify the priority values (e.g., link science to decisions versus generate new knowledge) behind the funding competition, both in terms of desired outcomes and process." While these were the only objectives explicitly forwarded in the survey, the focus group discussions did generate some themes could be posed as alternative objectives. I will discuss those later in the "Results" section.

Research Question 2: Of the six objectives, which objectives were viewed as most important? When participants were asked to choose the three most important of the six objectives, only one objective—Objective 2 ("Research better reflects user input on needs")—was selected by all 13 people who took the survey (see Table 31, below). Objectives 1 and 3 through 6 received, respectively, 6, 6, 5, 3 and 4 votes, showing a fairly well dispersed range.

Table 31: Results of survey question asking program reps to ID three most critical objectives. For complete descriptions of objectives, see Table 29.

Program & Reps	Obj. 1 Methods	Obj. 2 Needs	Obj. 3 Iterative	Obj. 4 Power	Obj. 5 Account	Obj. 6 Support
Climate		Yes	Yes		Yes	
NCCOS-1	Yes	Yes			Yes	
NCCOS-2	Yes	Yes		Yes		
CSC	Yes	Yes			Yes	
Sea Grant (Nat'L)	Yes	Yes		Yes		
Sea Grant (MI) -1		Yes	Yes			Yes
Sea Grant (MI) -2	Yes	Yes	Yes			
Graham Inst.		Yes	Yes	Yes		
Maine Sustain		Yes		Yes		Yes
SESYNC	Yes	Yes				Yes
CA-OST-1		Yes	Yes			Yes
CA-OST-2		Yes	Yes	Yes		
Switzer		Yes				

In a subsequent exercise, programs were asked to indicate what objective was paramount in their opinion: that is, of greatest importance in terms of linking science to decision making. Surprisingly, as shown in Figure 17 below, Objective 2 only received one vote, while Objective 1 received four votes and Objective 3 received two votes.

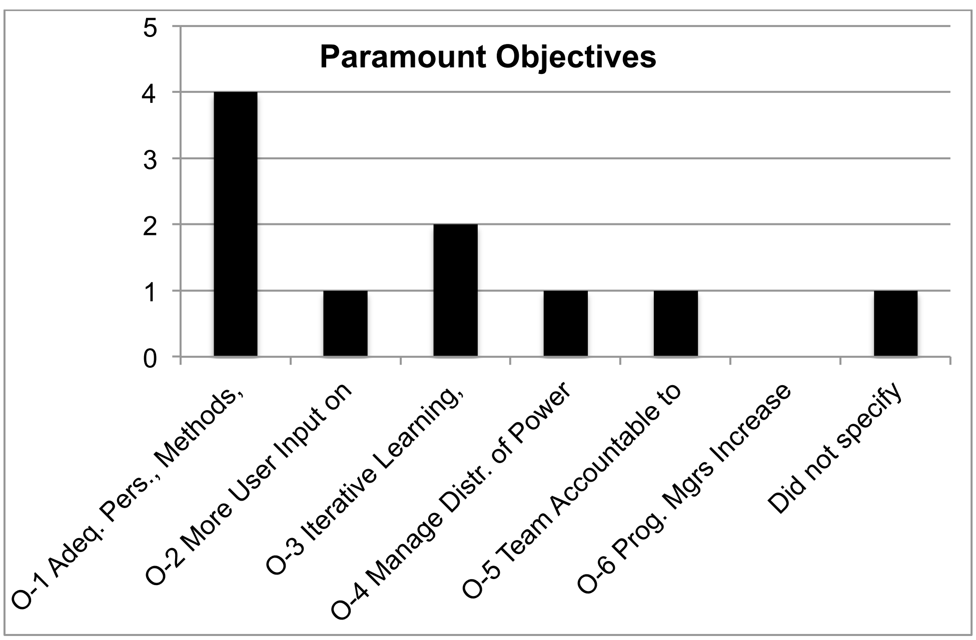

Figure 17: Number of programs indicating that a certain objective was of the most importance in terms of linking science to decisions.

Objectives 4 and 5 both received one vote. On the one hand, these results suggest that all the objectives garnered some support. In addition, none of the objectives are necessarily in tension with each other. In other words, fulfilling Objective 1 does not make it less easy to fulfill the other objectives, except for the fact that resources are limited and one may be challenged to focus on more than several of these objectives. Therefore, funders should be curious if any of these objectives have more leverage than others; that is, fulfilling that objective makes it easier and more likely to fulfill others. For example, in support of Objective 3, one program noted: “What we’ve really learned is that almost all of these objectives can be met if you set up a program or project structure that's flexible and adaptive enough to iteratively learn.” One could also argue that fulfilling objective 1—making sure that the project had appropriate personnel, methods and resources for linking science to decisions—would greatly increase the likelihood of achieving other objectives, especially objectives 2 and 3.

Research Question 3: What best practices, based on the focus group’s feedback, emerged as most likely to effectively link science to decisions? As indicated by Figure 18 below, in general, the programs agreed with the Best Practices. Yet some of the comments in the survey and in the focus group indicate that some participants had more significant concerns with the best practices than Figure 18 leads one to believe.

Table 32 indicates that Best Practices 2 and 5 (corresponding to Objectives 1 and 2, respectively) were both particularly contentious. I forwarded the notion, based on my experience (Matso 2012; Chapters 2, 3 and 4), that having an equal number of reviewers examining the science linking activities in the proposal as there were examining the science generation was critical. Several participants had concerns about this approach and noted that there were other ways to fulfill the objective of ensuring rigorous linking methods. One participant suggested the use of decision makers on panels as an alternative (see Table 32). Others required clarification of the types of reviewers the author was recommending (see “Discussion” section).

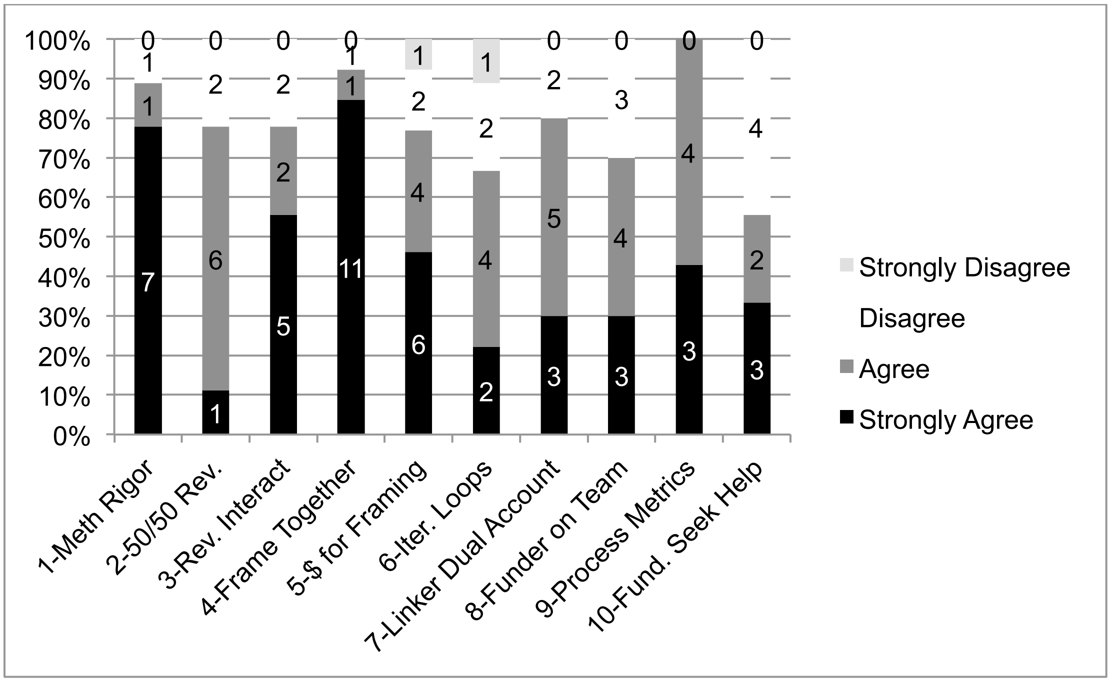

Figure 18: Survey results indicating levels of agreement for the 10 Best Practices. Note that not all Best Practices were reviewed by the same number of programs. Programs were given four choices (strongly agree; agree; disagree; strongly disagree).

Best Practice 5 also garnered several concerns from the participants. This is of particular importance since this best practice is one of two that corresponds to Objective 2, which participants agreed was a critical objective (see Table 31). As indicated in Table 5, concerns were diverse and, in some cases, in opposition to one another. For example, one participant noted that this wasn’t the responsibility of the funder while another participant asserted the opposite. Others clearly had concerns about integrating needs assessment into the scope of work supported by a grant.

Table 33 indicates that Best Practices 7 and 8 (corresponding to Objective 4) ellicited concern from several participants. Best Practice 10, associated with Objective 6 also ellicited several comments. In contrast with Objective 4, Objective 6 had a greater

Table 32: Best Practices 1 through 5 along with concerns and alternatives that emerged from the survey's qualitative section and the focus group discussion. Number of programs noting concerns or alternatives is shown in parentheses. Supporting comments were also made for each Best Practice but these are not shown due to space limitations.

Best Practice	Concerns	Alternatives
1) Funders request same level of rigor for science linking methods as for science generation methods; & funders are clear that both are a priority.	- ok with equal rigor, but it should be a different kind of rigor, not necessarily as academic (1) - not sure it by itself leads to more linking (2)	n/a
2) Funders ensure that they find and use experts in science linking (e.g., participatory process experts) to review relevant components of the proposal. Ideally, there should be as many science linking reviewers as science generation reviewers.	- seems too academic & not practice-based enough (2) - don't need same # of reviewer types (1) - other ways to accomplish this (2) - approach will differ according to proposal (2) - who are these experts? (2)	- use decision makers on review panels (1) - use past performance as a review criterion (1) - change org. culture so it becomes more solutions oriented (1)
3) Funders should ensure that different kinds of reviewers have the opportunity to interact & learn from each other via the review process.	- doesn't seem relevant to the objective (2) - not sure it by itself leads to more linking (1)	n/a
4) Funders should use RFP to define & raise minimum extent to which investigators and users need to work together to frame the problem and agree on a research approach, either during proposal development or as part of the project itself.	- don't be too prescriptive (1)	- have users help frame the RFP itself also (2)
5) To accommodate project teams that have not had the time to collaboratively frame the problem and research approach, funders need to provide a mechanism to offer financial support for this activity. This can be done by either a) allowing needs assessment research within the main grant competition, or b) by offering a separate competition for this purpose.	- this stretches research budgets too much (1) - this should happen but not sure it's funders task (1) - not sure needs assessment should be grant funded (1) - like the separate competition approach (2)	- funders should do this rather than the teams (1)

amount of support (see Figure 17), so this seems to be a particular case of people reacting to the wording of the best practice. For Best Practice 10, as with Best Practices 4, 6 and 8, participants reacted to the prescriptiveness of the best practice (Table 33). In fact, there was a clear theme from the group that many of the best practices were well intended but too rigid and narrowly constrained considering the many different kinds of

Table 33: Best Practices 6 through 10 along with concerns and alternatives that emerged from the survey's qualitative section and the focus group discussion. Number of programs noting concerns or alternatives is shown in parentheses. Supporting comments were also made for each Best Practice but these are not shown due to space limitations.

Best Practice	Concerns	Alternatives
6) Require or encourage proposals to include at least two iteration loops (i.e., a pilot study) within the research project. Each iteration should include: needs assessment, research design, research implementation, and linking of results to decisions. Each iteration should be followed by an assessment of appropriate changes for future iterations.	- too rigid & prescriptive (3) - hard to understand (1)	- clarify that this can be done via workshops, not necessarily pilot studies (1) - require researchers to show specific opport-unities for exchange and adaptation to user concerns (1) - funders provide guidance for this aspect of the research (1)
7) Funders should use RFP and the award contract—as well as a post-award verbal communication—to make clear that the person in charge of linking science w/ decisions on the project is accountable to both the project team and to the funders. (This is similar but distinct from the Principal Investigator role, which is accountable to the funder for the general administration of the project.)	- linking should be important to more than 1 person (1) - hard to understand (1) - feel like the person would be in a weak and/or awkward position (2)	- ensure home institution of grantee supports goals of the program (1)
8) Funders use the RFP and the award contract to clarify that all projects will have a partnership management structure, with one component of the partnership represented by an investigator from the project team and the other component represented by a staff person from the funding organization.	- may not always be appropriate (2) - overly prescriptive (1) - overly administrative (1)	- ibid above
9) As part of the award process, funders should develop process-based metrics with the applicant team and tie continued funding to the team's ability to meet expectations.	- most already do this (1) - expectations should be adaptable and process-based as well (2)	- RFP should clearly state the values behind the funding opportunity (1)
10) If funder does not have someone on staff with the time and significant experience linking science with decisions, the funder should contract with such a person to help oversee these aspects of the funding process throughout all stages of the competition and project implementation.	- not always necessary (1) - not always possible (1) - good idea but don't be too prescriptive (3)	- funders can acquire the skills to do this themselves (2)

research projects and funding organization contexts that are possible. As will be discussed later in the article, participants evolved towards an approach of offering alternatives as opposed to "best practices."

Other Emergent and Salient Themes The focus group was designed to gather feedback on a set of objectives and best practices but to also generate discussion ideas outside of these pre-set topics. For this portion of the focus group, the participants were reminded to focus on the question: What can funders to better link science to decisions?

Table 34 below shows that the qualitative analysis of the focus group discussion resulted in 22 categories, which have been placed into four bins ("concerns," "Funder Actions: Program/Project Level," "Funder Actions: Broader Level," and "Empirical Observations) so that it will be easier for the reader to take in the information. Thirteen of the 22 categories were supported by multiple programs, with only five of the categories mentioned by five or more programs. Since the purpose of the focus group was to look for convergences of ideas, I will use the next few paragraphs to highlight those categories upon which five or more programs converged. First, I will review the program/project level categories.

"Be aware that no one formula will work for every situation" was noted by six programs and is best exemplified by this quotation from the Michigan Sea Grant program: "There's no one specific way that this happens within a project and it might be damaging to be too academic or rigid in the structure."

"Acknowledge that linking happens thru people and relationships" was noted by five programs and is best exemplified by this quotation from the Maine Sustainability program: "We'll need to go beyond [duration of typical grant cycles] because making a difference ultimately comes down to relationships. Trust in social networks is a key to this and many of you already mentioned this and others have it in your slides."

Table 34: Categories and themes emerging from the focus group discussion on what funders should to better link science to decisions.

Row #	Concerns	Program Code
1	Funders face constraints in using some of these best practices	T
2	Don't focus on process to the short shrift of the end goal	O
3	Can't be a boundary spanner from far away	I
	Funder Actions – Project Level	
4	Having science be place-based helps link it to decisions	C
5	Science translation is important for linking science to decisions	C
6	It's important to be able to cut off funding if it's not working well	S
7	Focusing on the process of linking science to decisions is critical	M
8	Scientist – User interactions must be purposefully planned	M
9	Acknowledge that linking happens thru people and relationships	O-S-M-P-E
10	Foster experimentation and assess the expected & unexpected	I-S-F
11	Keep in mind it can take a decade to cause and track change	I-S-P
12	Projects should better integrate natural and social sciences	C-M-P-E
13	Fund co-production systems that include boundary spanners	I-S-M-E-F
14	Be aware that no one formula will work for every situation	T-C-O-M-G-F
	Funder Actions – Program Level	
15	Focus group topic needs to be taken up beyond the choir	T-E
16	Need to use org behavior to better link science & decisions	T-O-I-S-M-P-E
17	Many orgs with different strengths need to leverage better	C-O-E-F
18	An explicit community of practice could be helpful re linking	T-P-E-F
19	Delineate a career path and skills for leaders in linking	T-S-P-E-F
	Empirical Observations	
20	Co-production model can link to decisions before work is done	M
21	Society is shifting the paradigm towards more linking	G-P
22	Surprised by how resource-intensive boundary spanning* is	T-S
	Key to Participant Codes	
	Climate Program, NOAA	P
	Center for Sponsored Coastal Ocean Research, NOAA	O
	Coastal Services Center, NOAA	C
	Sea Grant National Program, NOAA	G
	Michigan Sea Grant, NOAA and State of Michigan	M
	The Graham Environmental Sustainability Institute	I
	Maine Sustainability Solutions Initiative, funded by NSF	S
	National Socio-Environmental Synthesis Center, funded by NSF	E
	The California Ocean Science Trust	T
	The Switzer Foundation	F

Far right column designates which programs are associated with the category. Abbreviations explained in the shaded key area. *The term "boundary spanning" refers to the activity of moving between different disciplines and institutions, which may lack the ability and responsibility to do so themselves (Guston 2001; Pietri et al 2011). Cooperative Extension is the classic example of a boundary spanning entity.

"Fund co-production systems that include boundary spanners" was also noted by five programs. The idea was first articulated by the Graham Institute program and then others agreed and referred to it repeatedly in the discussion:

> I've come to the conclusion that, if you really want to have this work done, you need to fund it directly. We need to move away from the mode of: 'We're funding research and trying to make it useful.' Or, 'We're trying to identify a problem and then finding research to satisfy it.' I think we actually need to fund the organizations that are bringing the people together to do that and have them bring both sides to the table rather than trying to fund people to move into territories they're not comfortable with.

The following two themes begin to transcend the scale of specific projects and programs. Frankly, as facilitator, I attempted to guide the discussion back to what I saw as more "achievable" objectives and themes that could be accomplished through projects by one single program manager. However, it was very clear that many in the focus group felt that these broader themes were a very important part of the solution if we are to better link science to decisions.

"Need to use org behavior to better link science & decisions" was supported by six of the 10 programs and is exemplified by this quotation from the Maine Sustainability program: "Funders might be able to get more return on their investments if they helped support such large-scale efforts to change the culture (including the incentive systems) of research institutions." A representative from the CA Ocean Science Trust program, reflecting on the NERRS Science Collaborative, noted: "I'd like to see more reflection on what did it actually take for the NERRS to be able to have this flexibility to change the processes in order to move towards a solution that works a little better in terms of linking science to policy. How do you overcome barriers when you're trying to do that?" Finally, the following quotation from the Graham institute reflects a common concern about academic incentives getting in the way of changing how we link science to decisions:

> Finally, I end with this: all of this is really well and good but it's a challenge inside academia often to get the best people working in this mode because often the best people are the new young assistant professors, who are challenged to work in a multidisciplinary, multiple dimension world, and the tenure process can often get in the way of that."

“Delineate a career path and skills for leaders in linking” was supported by five programs and is exemplified by this quotation from the CA Ocean Science Trust: “These ideas about better communication and integration…Unless there are career paths, what they really do right now is just put a tremendous amount of pressure on the scientists and other people in this system without the proper incentives at the other end.”

Discussion

The goal of this research, as noted earlier, was to build on the helpful advice to program managers offered in previous reports (e.g., NRC 2006; NRC 2009; Dilling et al 2010) and bring the discussion to a finer resolution scale so that program managers can consider an array of specific actions that may help them better link science to decisions. My method was to share results from Chapters 2, 3 and 4 with a sample of program managers, all of whom agree that funders need to be better link science to decisions, but do not necessarily agree on how to achieve this. This is the first step in beginning to generalize my results (Yin 2003), akin to repeating a new seagrass restoration technique in different water body to see if similar results are attained.

A quick review of the three reports cited above—perhaps some of the most useful reports currently available to funders—indicates that much of the focus group discussion inhabited space within the parameters set by these documents (see Table 35 below). Two ideas from these reports, however, are exceptions and are worth noting.

First, the idea embodied by NRC 2006 Recommendation 6 and NRC 2009 Recommendation 5 did not come up directly in our discussion: yet the importance of these recommendations are undeniable and worth attention. No matter how good the strategic planning and execution of a program, if funding is not maintained at a high enough level, the effectiveness of the research is compromised. Second, NRC 2009

Recommendation 2—"Give priority to process over products"—touches on a point of debate within the focus group. This will be discussed later in this section.

Table 35: Review of main recommendations from three reports on linking science to decisions.

NRC 2006 Recs	NRC 2009 Recs	Dilling et al 2010 Recs*
1) Define problem with users	1) Begin with users needs	Fundamental Conclusion: *Science best meets the needs of decision makers when those needs are considered throughout the institutions, policies and processes that comprise the scientific enterprise.*
2) Define clear project goals and accountability.	2) Give priority to process over products	
3) Use a boundary spanning organization that is account-able to both scientists and users	3) Link information producers and users	
4) Place work in a decision chain and be aware of links on either side of the chain	4) Build connections across disciplines and organizations	Main Recommendation: *Create specific criteria for verifying the usability of scientific results, and specifically account for the outcomes which R&D programs aim to fulfill.*
5) Experiment and incentivize innovation in program management	5) Seek institutional stability	
6) Be creative in ensuring continuity and flexibility of budget	6) Design processes for learning	

***Note that the format of the Dilling et al report is different from the other reports; rather than focusing on recommendations, it focuses on dispelling myths, discussing rationale and offering case studies. It is an excellent resource.**

The focus group discussion involved recommendations at both the broad program scale as well as the specific project scale. Also, as predicted, the focus group offered finer resolution suggestions on how funders can follow the principles listed in Table 8, such as "define problem with users" and "link information producers and users": principles that are hard to argue with but also leave generous room for interpretation from an operational standpoint. First, let us turn our attention to some of the broader program-wide, or even institution-wide, suggestions.

<u>Funders Working at the Broad Program/Institutional Scale</u> Not all funding organizations have the resources to tackle some of the broader suggestions made by the focus group. On the other hand, some funding organizations, such as divisions of NSF, do have these resources. For example, NSF has the funds to invest in project-scale efforts to link

science to decisions, but it also has the ability to fund programs like the Maine Sustainability Solutions Initiative, at a pricetag of 25 million dollars over five years. This Initiative is producing research to address pressing problems in Maine, but it is also simultaneously conducting social science research to better understand how the organizational culture at the University of Maine needs to change in order to better link science to decisions. This kind of social science addresses the category “need to use org behavior to better link science and decisions,” indicated by Row 16 of Table 34.

The Maine Sustainability Solutions Initiative is also an example of the complete co-production system model noted by Graham Institute, in which the initial funder, NSF, essentially duplicates itself by entrusting the University of Maine to gather natural and social scientists as well as boundary spanners, to work with diverse users in solving environmental issues. Another example would be the Regionally Integrated Scientific Assessments (RISA) program, funded by the NOAA Climate Program.

This approach of directly funding the co-production of science received a great deal of support within the focus group. It integrates many of the funder actions noted in Rows 4 through 14 of Table 34. This notion was seconded by both the Graham Institute and Michigan Sea Grant, both of which employ a framework called Integrated Assessment (IA) (Lund et al 2011), which encapsulates many of the ideas discussed in this paper. Don Scavia, who brought IA first to Michigan Sea Grant and then to the Graham Institute noted that it was difficult to sit in Ann Arbor, Michigan and expect to be an effective boundary spanner throughout the state. In slight contrast, the Sea Grant program is able to rely more heavily on its extension agents for this function. Either way, Scavia’s work on both sides of the fundee and funder fence have led him to support a model where a program solicits a proposal to set up a complete system, with the capacity to conduct natural science, social science and interact with stakeholders in order to affect policy and decisions.

If a funding program has the resources and motivation to emulate this approach, that program still needs to be very explicit in terms of how it expects to link science to decisions.

Fund Scientists and Help Them Make the Knowledge Usable? Or Fund Boundary Spanning Systems? Many applied science models, including the Collaborative, to an extent, fund investigators who are primarily specialists in their fields but expect these specialists to operate in ways that may be unfamiliar to them. In contrast, Scavia suggests only funding entitites with a track record for working in a boundary spanning mode, and have them disperse funds as appropriate. It is possible that such an entity, with less allegiance to a specific kind of research, would be better able to judge what kind of science (e.g., biophysical, social, a combination of both) is most needed to solve a particular problem. It is conceivable that they would be more likely to fund both biophysical research as well as social science that targets some of the barriers and opportunities at both the individual and organizational behavior level, as the Maine Sustainability Institute is doing. As shown in Table 34 (see Rows 12 and 16), integrating this sort of social and policy science inquiry was seen as very important by many participants in the focus group.

Shaping the “linking” leaders of the future emerged as another important way to improve how our society links science to decisions (see Table 34). This could be something the funder does directly in tandem with project-based work, giving students the opportunity learn in a real-world setting. For example, the Collaborative is piloting a Masters level program—Training for the Integration of Decisions and Ecosystem Science (TIDES)—at the University of New Hampshire. Foundations like the Switzer Foundation have these sorts of activities at the core of their missions. Federal agencies such as NOAA and NSF have many education programs as well, although it is unclear how many of them are dedicated to boundary spanning.

Alternatively, funding a community of practice emerged as a popular idea in this focus group. James Boyd, the representative from the NSF-funded National Socio-Environmental Synthesis Center (SESYNC), was especially interested in this idea since it is related to SESYNC's core mission. Boyd made the argument in the focus group that a community of practice could help address other issues that came up, such as how to better leverage the different strengths of different but related organizations (Row 17, Table 34). He also pointed out that a well functioning community of practice can help funders continue to massage all six objectives proferred in this study.

I will now consider the salient decisions if a funder chooses instead to work at the project scale. Note that some of these issues—such as how much to focus on process; how to structure the proposal review, etc.—may also be relevant to programs funding entire co-production systems.

<u>Working at the Project Scale</u> First, I want to acknowledge that projects, like programs, can fit the co-production model discussed above. In a way, this is how the Collaborative was set up. Every project team must contain the elements of the entire system: scientists with a background in the problem, whether it be human behavior or the behavior of sediment or phytoplankton; a boundary spanner charged with managing the participatory process; and intended users of the science.

The key difference, and an important one for the Collaborative to consider in the future, is that the Collaborative does not stipulate who actually gets funded; the program will fund an ecologist, a boundary spanner, a social scientist or any other entity. Instead, it demands that certain role players exist on the team and have certain responsibilities. This is essentially a hedge of the question posed earlier: Do we fund scientists and make the science usable or do we fund boundary spanners? We decided not to be rigid in our answer to this question, but this could warrant revisiting. We have noted that most of our applicants continue to be biophysical scientists simply because, currently, these actors are most empowered to go after competitive grants involving environmental problems. On the other hand, this could change with education as the paradigm continues to shift.

How will the funder ensure (as noted in Objective 2) that the research suits the needs of users? As shown in Table 31, every focus group participant thought that Objective 2 was one of the three most critical objectives. In addition, Objective 1 got most votes for the "paramount" objective, partially because it was seen as an efficient way to get at other objectives. Objective 1 stated: "ensure that the project has appropriate personnel, requisite methods and adequate resources (time, money) to best link science to decisions." The Collaborative's approach to solving this issue is to make sure the project team has someone well versed and trained in participatory processes. In order to achieve this, the Collaborative requires as many process experts on the review panel as there are experts in the science of the particular problem.

The focus group results, however, show that this is either a polarizing or misunderstood approach (see Table 32.) Some funders thought this was a good idea but that the review panel didn't have to be balanced per se; perhaps only one process expert was needed. Others felt that it was inappropriate to demand the same level of academic rigor for process as is demanded for science generation methods. Others wanted to know more about the process experts; who are they exactly? The main alternative to this approach—to make sure the science was grounded in user needs—was to have actual decision makers on the panel (see Table 32). (In contrast, only one program came out in support of this focus on process; others were non-commital.)

This may be the most surprising finding of the focus group to me and it has stimulated the most amount of brain and soul searching. Perhaps the reason I and my colleagues are so attached to this particular strategy is that we have seen it in practice and we see that it produces very different results than a typical review panel without the process experts. (We have tried using decision makers on panels and have not been as impressed with the results; instead, we feel it is best to involve decision makers in the projects themselves.) In contrast, it was evident that none of the other people in the focus group had actually tried a completely balanced review process; they haven't seen it in action and gotten the positive feedback we have.

While we can say the process makes a "difference," it is too early to say whether the proposals will have a longer-term impact in terms of linking science to decisions. However, we can say unequivocally that this process results in proposals that have more details and more resources dedicated to the linking aspect of the work. Details and resources are often correlated with higher effectiveness so we have been encouraged. Additionally, the reviewers themselves have been extremely appreciative of the approach: both the process experts and the experts examining the science generation part of the proposal.

Trying to be open minded, I could see that a perceived downside to such a process would be a waste of resources. Also, proposals that have solid science generation methods but insufficient process methods would not get awarded under our approach. Certainly, some of the applicants who have repeatedly gotten rejected by our review panels would agree with this notion. This prospect might be especially distasteful to professionals who have been educated with a focus on the crediblity of the science generation methods. It is interesting to note that nine of the 13 focus group participants were trained as biophysical scientists (see Table 30); two were trained to examine the science-policy interface; one was an educator and one was an economist. With the possible exception of the economist, none of the participants were social scientists who study the human dimensions of natural resource problems.

The lack of agreement around the appropriate proposal review procedures as well as the broader issue of "process versus products" remains an issue that will need further discussion. In closing on this subject, I will note that NRC 2009, which put forward the surprising recommendation to "give priority to processes over products" acknowledges the tension in this way:"

> To get the right products, start with the right process. Decision support is not merely about producing the right kinds of information products. Without attention to process, products are likely to be inferior—although excessive attention to process without delivery of useful products can also be ineffective. To identify, produce, and provide the appropriate kind of decision support, processes of interaction among and between decision support providers and users are essential. (Chapter 2, Page 40)

Regardless of how a funder tries to meet Objective 1, the issue of conducting needs assessments and how this fits into the competitive grants process may emerge as a difficult decision. For example, consider Best Practice 5: "To accommodate project teams that have not had the time to collaboratively frame the problem and research approach, funders need to provide a mechanism to offer financial support for this activity. This can be done by either a) allowing needs assessment research within the main grant competition, or b) by offering a separate competition for this purpose." Table 32 indicates that focus group participants were on opposite sides of this issue, with some saying that this was the funder's job and others saying that this needed to happen on the applicant's time and shouldn't be funded at all. Still others felt that needs assessment was fundable but under a separate competition from the main RFP. Two of the programs noted their practice of working slowly and carefully with intended users to craft the RFP itself.

In contrast, the Collaborative does allow needs assessments proposals as well as mixed proposals to its main RFP. By mixed proposals, I mean that the proposal cites their understanding of user needs based on prior conversations with users, but also lists continued work that will happen under the award to continually refine the needs assessment. In fact, most of the Collaborative's recent proposals are of this latter variety, since we have seen that user needs change over time and continually need to be re-assessed as the science is generated (see Chapter 2 and 3).

With regard to Best Practice 7 (Table 33), various concerns were raised about the weakness of having one person on a team responsible for the linking activities. This is the model used by the Collaborative and we have seen cases where these fears are borne out, particularly if the program managers have not made expectations clear from the outset. On the other hand, we've also seen cases where projects seem to be on a trajectory where these fears are not borne out. We believe the difference, again, is in clearly stated expectations in the RFP and review process.

Many of the focus group participants were enthusiastic about Best Practice 8—which mandates a partnership structure between the project team and the program manager—and noted explicitly that this practice has worked and is working for them. As an example, both CSCOR and Michigan Sea Grant rely heavily on program managers to help with boundary spanning activities. In contrast, the rationale for setting up teams that were "complete within themselves"—similar to the co-production model discussed earlier—is based on capacity building. Our notion was that we should incentivize—and in some cases, tutor—applicants to "fish" (read: link science to decisions more effectively) so that we, the program managers, would not be necessary for them to fish in the future, (except perhaps for funding.)

Of course, the above approaches are not mutually exclusive and each funder can experiment in order to find the most efficient method for providing support and oversight while also building the capacity of different groups to accomplish other boundary spanning activities on their own.

Conclusions

Number 1: ***Funders need to identify and differentiate between objectives and means, and then act accordingly***. Does the funding program judge itself primarily on producing credible science, or is addressing problems effectively the more important metric? I recommend funders use a text such as Gregory et al (2012) to clearly think through the differences between different kinds of objectives. Clarifying objectives and causal links facilitates more appropriate resource allocation, which is key to better connecting science to decisions. For example, the NERRS Science Collaborative decided that its main objective was better management of natural resources. This is very different from an approach that prioritizes credible science over other objectives.

Number 2: ***Once you have identified your fundamental objectives, allocate resources to each link in your logic chain***. For example, your logic chain might be: better problem formulation and communication → more credible and legitimate science → more linking science to decisions. Resource allocation decisions should then be based on this logic chain, not on unstated assumptions about how science disseminates through society. For example, like many funders, the NERRS Science Collaborative has under funded communication, especially when one considers how important communication is in linking science to decisions.

Number 3: ***Make sure your review process corresponds to your priorities***. If linking science to decisions is important, get experts who know how this occurs into the review process and make sure they have influence that is commensurate with your logic chain. For organizations like with a clear mission to link science to decisions, it is difficult to defend a review process that ignores expertise on how to link science to decisions, or involves those reviewers but gives them less influence than other reviewers.

Number 4: ***Problem definition is too important not too fund***. Funders assume that problem definition happens outside the core funded activities; yet if it's not being funded, it won't occur with rigor equal to the parts of the project that are funded. Also, problems are often mis-specified and, without sufficient resources, the project cannot adapt in order to respond to new knowledge. This focus group came up with various ways to achieve better problem formulation. I recommend building problem formulation acitivities/expertise into the funded teams and projects. This builds more societal capacity than relying on program managers located far from the affected communities.

Number 5: ***Build in processes that require an iterative approach to research***. This can be done by encouraging a pilot study within the research project. Alternatively, many accepted participatory process practices, such as Structured Decision Making (Gregory et al 2012) or Collaborative Learning (Daniels and Walker 2001) already have an iterative focus. Therefore, by demanding more rigorous and accepted methods for public participation, funders should be able to increase the adaptability of their research.

Number 6: ***Implement research on your research***. Reserve some funds to explore how well the science you fund is linking to decisions and why.

Number 7: ***Contribute to the long-term capacity of our society to better link science to decisions through education and career path delineation***. There is a dearth of education programs and clear career opportunities for professionals who want to work at the interface of science and policy (NRC 1995; Susskind and Karl 2008). Funders need to be part of addressing this solution by providing funding to these efforts and by presenting on this topic at appropriate venues.

Number 8: ***Participate in a community of practice***. Linking science to decisions is a new and dynamic area of inquiry. By participating in a community of practice, funders can learn from each other and help diffuse innovation in funder best practices. In light of current budget limitiations as well as carbon footprint concerns, communities of practice can easily be conducted using virtual technology.

CHAPTER 6

DOUBLE LOOP TIME:
ASSESSING THE MODEL AND PREPARING FOR FUTURE CHANGES

Introduction

In the NRC 2009 report "Informing Decisions in a Changing Climate," the authors define the concept of "double loop" learning—originating from the work of Argyris and Schon (1978)—and note that addressing climate change issues will no doubt require double loop learning in addition to single loop learning. I believe double loop learning is also necessary for funders who want to better link science to decisions.

According to the double loop theory, we all have a model of reality, whether it is explicit or implicitly stated. As a scientist and a science program manager, I began in 2003 with a model of reality that saw society hungering for the rationality and accuracy of scientific thought. Therefore, all my attention was dedicated towards ensuring and increasing the rationality and accuracy (i.e., credibility) of the science our organization produced. Acting in accordance with "single loop" learning, any failures in terms of science linking to decisions would trigger an increase in resources to support my model of reality. In this case, I would react by trying to fund more credible science, arguing for more funding to do more science in the current mode. Double loop learning, on the other hand, involves surprises and concepts outside of one's vision of reality and therefore requires organizations to modify not only their operational approach but also their underlying operating theory (NRC 2009).

Almost 10 years after being asked by my boss to investigate how science can better link to decisions, I find myself reflecting on evidence that strongly suggests that I need to revise my operational theory of how science can best be used to help society address pressing natural resource management issues. The previous chapters provide evidence that people continue to depend on science as a source for credible data and tools. At the same time, even more evidence points to a feeling that the most common methods for bringing credible science to bear on societal issues needs significant tinkering if not a major reconfiguration of the conventional model: in other words, a radically new approach. In a moment, I will offer an overview of the evidence referred to above. First, however, I would like to shine the spotlight on one particular finding that I think deserves a little extra attention: the need for better problem formulation.

The issue of better problem formulation may provide the most salient impetus for a reconfiguration of our current approach to linking science and decisions. For urgent problems that involve diverse views of reality and cultural values, the problem definition step is absolutely paramount. Sarewitz and Pielke's work (2007) on reconciling the supply and demand of science is probably the most well known academic articulation of this issue, but it is also emphasized by Rittel and Webber's seminal paper on wicked problems (1973) as well as Clark's textbook on policy sciences (2002). The famous statistician John Tukey—as cited by Mitroff and Silvers (2010)—once stated: "Better a poor answer to the right question than a good answer to the wrong question." For both CICEET and the Collaborative, two programs that went to uncommon lengths to embed new research in thoroughly vetted problem statements, the issue of inadequate problem framing is still rearing its head. This is true even now while we are on our ninth iteration of ratcheting up the requirements for improved problem framing.

"Better a poor answer to the right question…." Why is this so? A credible answer is just not useful (in the near term) if the question being answered is only relevant to a select few people ensconced in government and academia: not when the problems are deeply entrenched in diverse economic, political and cultural values. I admit that this is not and should not be true for some kinds of science, such as science focused on indefinite rewards decades from now. However, CICEET and the Collaborative were not created to produce that kind of science, which is much more removed from intended users and the intent to address problems in a timely manner. I agree with one of the collaboration leads from the Collaborative's first cohort, who said:

> I love basic science. I want to see it done. What I don't like to see is scientists who want to do basic research essentially dipping into the pots of money for applied research under the guise that it is applied research. I've seen way too many proposals where the first paragraph is about how 'this is really relevant and this research will change the world' and after that it's a basic research question that gets published in an academic paper and never gets out to the real world, and didn't really have much application anyway.

Another reason that thorough problem framing is so important is that the activity of more thoroughly understanding the context has tremendous leverage. That is, adequate problem framing requires some of the activities that also emerged as salient in these studies. A truly thorough problem framing process requires: 1) more communication of scientific findings that have occurred up to this point, and 2) more opportunities for scientists and users of diverse backgrounds to learn from each other. The above two factors figured prominently in essentially all 13 case studies that have been discussed in this dissertation.

However, the need for thorough problem formulation was not the only salient finding of this research. In the next section, I will review the most salient findings and articulate some of the options for adaptation facing me, as a researcher, and as staff at a funding program that has only two years left of its five-year grant. It is unclear whether the University of New Hampshire will get another five-year grant with which to implement lessons learned. Nevertheless, these findings may remain relevant no matter what the future of the Collaborative.

I will also articulate my recommendations for those outside the Collaborative who may also be interested in better linking science to decisions. Under the heading of "recommendations" I will discuss some future research questions that should be considered by people interested in this subject and I will also point out some of the most salient lessons I learned with regard to qualitative methods.

Overview of Findings

Figure 19 and Figure 20 offer an extended timeline showing how CICEET and the Collaborative, from 2007 to the present, have continually adapted in attempts to better link science with decisions. Although the details of how CICEET and the Collaborative ran their processes have changed, one thing has remained consistent since approximately 2007. We expect our awardees to include specific measures to increase the credibility, relevancy and legitimacy (Cash et al 2003) of the research, starting at the inception of the proposal. Also shown on the right side of Figures 19 and 20 are the salient findings from these efforts. Of course, this 10,000 foot view requires that we lose the focus on many important findings and details, yet I believe it is worth it, at this stage, to focus on the most salient results.

Findings from Chapters 2, 3 and 4 Figure 19 highlights that certain findings emerge consistently from the three RFPs studied (see Appendices A, B, and C), despite CICEET and the Collaborative's modifications between each competition. The left side of the figure shows a gradual increase in the specificity of CICEET/Collaborative demands for public participation, culminating with the “Collaborative Science at the Reserves” RFP (bottom of Figure 19), which requested detailed methods and a collaboration lead. This RFP also represents the first time that participatory process experts were involved in the process, although, critically, these experts were not on the final panel, only at the write-in review stage. Therefore, their views and desires for rigor in the participatory methods did not have a champion in the final panel process. The Collaborative keenly felt the absence of those perspectives during the process and rectified this skillset gap in the next competition (see Figure 20).

First, notice that effectively communicating the findings of the research is salient for all three competitions showed on Figure 19. Communication was even stressed for Collaborative projects, even though the research on that competition was squarely focused on how to conduct more effective meetings, as opposed to a discussion of how projects in general can better link science to decisions. What was valued in those meetings was, first, the attention paid to the eventual task, at the end of the project, of actually communicating findings to a broader group of users. Second, many interviewees noted that investigators need to think more critically about how they communicate; how they offer slide presentations; and how they choose the terms to use in their talks. You may not agree with this intended user from Alaska, but you have to pay attention to the broader implications of his plea when he notes: “Don't use the metric system when you're trying to explain things to non-scientists. And use plain English; get away from the Latin and the Greek terminology.”

With regard to communications, what are the implications for funders? First of all, it’s important to recognize that communications involves two major activities: one, communicating findings with users as results emerge; two, communicating effectively during the project as choices are made about problem formulation, etc. For these activities, the implications are that ff you want it done right, allocate the resources and

RFP & REQUIREMENTS	**MOST SALIENT FINDINGS**
Year 2007 Land Use Planning RFP (Fall ’07 to Spring ’10)	
Requirements - partnership with community - plans (not methods) for outreach, communication Review - panel only - no participatory process experts	To better link science with decisions, funders should invest more thought and resources in: - communication of findings - getting scientists and users engage more (in general) - getting scientists and users to engage (on the project) - define problem collaboratively and thoroughly
Year 2009 Addressing Land Use and Climate Change (Fall ’09 to Spring ’12)	
Requirements - “identified” personnel “leads for technical, collaboration, evaluation, dissemination aspects of the project Review - write-in reviews - panel - no participatory process experts	To better link science with decisions, funders should invest more thought and resources in: - communication of findings - getting scientists and users to engage (on the project) - making sure the tool will actually be used - define problem collaboratively and thoroughly - require more iterative approach to science
Year 2010 Collaborative Science at Reserves (Fall ’10 to Spring ’14)	
Requirements - Detailed methods for both “applied science” as well as for collaboration (or participatory processes) - Applied Science & Collaboration Leads Review - write-in reviews for applied (biophysical and social) science and participatory process - panel (no participatory process experts)	To better link science with decisions, funders should invest more thought and resources in: - communication of findings - more user participation, (less passive listening) - more time for discussion - expand diversity of users

Figure 19: Timeline showing three studied RFPs, salient requirements, and salient findings from the analysis.

RFP & REQUIREMENTS	**MOST SALIENT FINDINGS**

Analysis of Collaborative Year 1 Review Process (Matso 2012)

Goals - Better understand discrepant views of "collaboration" and participatory process Methods - Qualitatively analyze: o 116 peer reviews o 6 in depth interviews (3 biophysical; 3 participatory process)	- Further improvements by funders are needed to better link science with decisions - Participatory reviewers aware of and place high value on biophysical science. - Biophysical reviewers NOT aware of or placing high value on participatory process methods - Biophysical reviewers believed participatory processes as being in tension with scientific credibility. - Participatory reviewers see two kinds of methods as strengthening each other - All agreed review processes should be structured to increase understanding of "the other side."

Year 2011 Collaborative Science at Reserves (Fall '11 to Spring '15)

Requirements - Detailed methods for both "applied science" as well as for collaboration (or participatory processes) - Applied Science & Collaboration Leads Review - No write-in reviews - 50/50 Rule o two applied (biophysical and social) science panelists o two participatory process panelists	To better link science with decisions, funders should invest more thought and resources in: - More guidance and informal discussions between applicants and program - Continued support after award, especially at beginning of project Early Feedback - More personnel time and budget allocated to participatory processes - Four of seven initial project meetings have occurred; all evidence so far is that the meetings are matching or exceeding program expectations.

Innovative Funders Focus Group (May, 2012) – Chapter 5 of Dissertation

Goals - Understand areas of consensus amongst 10 different funders - Collaboration Lead Methods - Qualitatively analyze: o survey o event transcript	Project Scale Funder Actions - Use combination of program staff and community-embedded resources to collaboratively frame problem more effectively - Consider direct funding of co-production systems, rather than funding one type of scientist and hope that they will work across disciplines Program Scale Funder Actions - Use social sciences (e.g. organizational behavior) to better understand how to create broad culture change - Help develop the "linking" leads of tomorrow through education and career opportunities

Figure 20: Timeline showing Chapter 5 (focus group) results as well as results from an analysis of the Collaborative Year 1 review process and preliminary results from the Collaborative Year 2 (projects starting Fall 2011) competition.

make sure the right people have been assigned the task. In other words, use the same rationale you use when trying to create credible water quality data; make sure the methods are good and make sure the personnel and budget are adequate.

For the Collaborative, as we move into the future, failing to do this is becoming difficult for me to defend. The excuse for not doing so is either that communications is easy and can be done on the cheap by a biophysical science graduate student or that it is somebody else's job. The first notion comes from a deep ignorance of communications and/or a narcisstic view of the diversity of the disciplinary landscape. The second notion is essentially a cop out; where is this hypothetical other person who is supposed to be finding all the good science and then communicating it to the users? Who is providing their funding? In addition, it just makes more sense for the communciations work to be done in close collaboration with the knowledge production efforts. Interviewees on several projects noted that scientists have to be part of the communications process; they don't have to manage it or be the designer of the process, but they have to be there to add that sense of credibility and to nurture the trust that emerged as critical in multiple projects.

These implications also apply to a second finding that is consistent throughout Figure 19. We need more engagement between scientists and non-scientists, within the context of a research project. However, many interviewees noted that society would benefit from less bounded and project-specific opportunities to talk about problems and solutions as well. When discussing projects as a whole (first two RFPs in Figure 19) or when narrowing in on a specific meeting (research related to the last RFP in Figure 19), engagement topics ususally focused on setting aside more time for discussions. When discussing meetings, however, interviewees targeted comments not only at the time alotted for discussions but also on the general format. Essentially, this came down to a call to reassess and move beyond the format inherited from technical conferences wherein experts give unilateral lectures and then users get to ask questions, usually for far less time than the experts are allowed. This format is not ony unbalanced, it also flies in the face of years of research in the area of adult learning; when people are talked at rather than engaged, their brains are less creative and less able to learn.

As already discussed, the issue of more thorough problem framing was salient in the first two RFPs in Figure 19. This issue was not called out explicitly in the research on the initial Collaborative meetings (third RFP in Figure 19) because the interview questions centered around initial kick-off meetings, most of which were focused on coming to a common understanding of the problem facing the group. In Chapter 4, it was shown that interviewees found the projects distinctive for the early focus on collaboration as well as the fact that user input could actually modify the project. Therefore, it is possible that interviewees felt these projects were doing enough to define the problem collaboratively and, it is hoped, more accurately.

In terms of more thorough problem framing, what are the implications for funders? This is dealt with in some detail in Chapter 5. Essentially, funding program managers have to either do a lot more of the problem framing themselves via workshops, etc., or they have to be willing to fund problem framing directly…or both. In my opinion, one downside to relying on the former approach is that the managers of the process—in this case, the funding program managers—tend to be the ones with the strongest connection to the activity's results. In other words, if the problem framing isn't run by the community, the results may be perceived as being "forced" upon them, and thus less legitimate.

An alternative approach would be for the funding program manager to simply set the broad parameters of the research area but let the more detailed problem specification be done by the applicant team, along with any accompanying applied science. In this case, the funder would want to make sure that qualified professionals were embedded in the process to guide the problem formulation activities. Funding program managers could still be present as sponsors or conveners, still exerting some influence on the process. However, following the co-production model espoused by Don Scavia in Chapter 5, the entire system of producers, users and boundary spanners would exist as its own modular unit, not reliant on a program manager located far away. This approach has the added benefit of building more capacity in our society for solving wicked problems. To adapt the old saw about "teaching a person to fish," funding program managers should be finding the fishers in these communities and empowering them, as opposed to the program managers doing the fishing themselves.

Finally, the issues of iteration and user diversity also emerged throughout the projects, although most saliently in the 2009 RFP and the 2010 RFP research (Figure 19). There is obvious overlap between these ideas and issues related to problem framing and communication of findings. If research is done in a more iterative manner, this produces additional groundtruthing on the problem framing as well as the utility of the research. In addition, multiple iterations of the research increase opportunities for communication and engagement. For two year projects, this would require advance planning so that some sort of pilot project occurs fairly early in the process, allowing project participants to work with actual data and reflect whether their initial decisions about research needs really are what managers need to address the problem.

Similarly, user diversity simply increases the problem framing and communication options, both in terms of collecting valuable local knowledge as well as reaching more components of the community, increasing the potential credibility, relevancy and legitimacy of the research. My own view is that increasing user diversity may pose the greatest methodological challenge to project teams, even those with participatory process experts. From my direct observations and from being a part of panel discussions between various participatory process experts, deciding on the appropriate diversity and size of the user group—and then figuring out how to actually get them to participate—seems to be the task with the least consistent understanding of the state of the art.

For example, consider this quotation from Tarla Rai Peterson, a professor of Wildlife and Conservation Policy at Texas A&M University, who has been engaged in public participation issues for over two decades. Here Dr. Peterson is responding to an interview question about how she would improve the initial stakeholder meeting for a NERRS Science Collaborative project beginning in the Fall of 2011, and located at the Mission-Aransas Reserve in Texas. (Data from these Cohort 2 projects are still being collected and so have not been presented as part of this dissertation.)

> One [improvement] I thought of was the composition of the participants. We brought some new people in but we still had the usual suspects. We need to bring in the heavy industry there, like petroleum. We also had another population that wasn't represented at all. We have for instance a lot of Vietnamese fishers who don’t belong to the traditional fisher crowds. They talk within themselves, but they have not participated in public participation efforts. I think it’s really important because of the change in the makeup of those who are engaged in commercial fishing in the Gulf.

Therefore, funders may want to give the issue of user diversity some extra attention, revisiting sources that spend more time on the rationale behind determining the composition and size of user groups (e.g., Susskind 1999; Daniels and Walker 2001; Clark 2002; Von Korff 2010). Doing so would allow the funding program managers to clearly articulate their own expectations and rationale for user diversity. I have seen firsthand that panels are more productive when the funding program is clear and transparent about its expectations.

The above example involving Vietnamese fishers also draws attention to the issue of cultural sensitivity. Although not as salient as other findings, I have seen several cases (e.g., involving Native American tribal representatives in Alaska) where certain populations have required a strategy unto their own. In some cases, certain populations may be willing to participate in the project, but not necessarily the project meetings. Alternatively, they may be willing to commit to the meetings, but they may require more proof that the process will be handled in a legitimate manner. These situations can require cultural knowledge and sensitivities that many researchers do not possess.

Findings from: a Review Process Analysis, Early Results from the Collaborative's Second Competition and Chapter 5 Figure 20 starts with data from my analysis of the Collaborative's first review process (Matso 2012) as well as some preliminary evidence dealing with the Collaborative's second competition. These are not data found in the previous chapters of this dissertation, but I discuss them here because this data was in hand before I convened the focus group in May 2012. These ideas impacted the focus group discussion, and they are relevant as I—and the rest of the Collaborative—contemplate how to adapt the program in the future.

For me, the most compelling takeaway from the study of the Collaborative's first review process was the difference in the way the biophysical reviewers viewed the world versus the way the participatory process experts viewed the world. In short, the latter group was aware of the former, but not vice versa. Since Chapters 2 through 4 all show that participatory processes are very challenging and complex, this familiarity chasm cutting across our scientific society is thrown into even starker relief.

How does this chasm play out as we try to build the capacity of these project groups to tackle wicked problems? I offer you this real-world example. An applicant and I were discussing why his proposal did not get funded despite the fairly strong reviews of the wetlands restoration science at the core of the project. I noted that his participatory process methods lacked details and familiarity with the state of the art. He was flabbergasted and told me that he worked really hard on those details. Here, I pointed out that no matter how hard he tried, as a career wetlands ecologist, he would not be capable of writing the participatory process section with enough credibility; he should get an expert. Frustrated, he almost yelled, “Well, where are these people?” I told him he should read journals like “Ecology and Society” and then call the authors. The line went dead quiet for a few seconds. Then, he said, “Shoot. You’re telling me these people have their own journals?” He then went on to say that I needn’t explain further because he just didn’t realize that this was an expertise that had rigor comparable to ecological methods.

The middle section of Figure 20 focuses on preliminary feedback and data the Collaborative has obtained on its second competition (see Appendix D for this RFP), which resulted in seven three-year projects beginning the fall of 2011. Initial feedback is important because the Collaborative changed its review process, partly due to information emerging from Matso (2012) but also from informal feedback as well as the interviews completed for Chapter 2. (Interviews for Chapters 3 and 4 were completed too late to inform the second competition’s review process, which was developed the year before.)

Based on Matso (2012), which also consisted of interviews with program managers from NOAA’s Climate Program as well as NSF’s Dynamics of Coupled Natural and Human Systems Program, the Collaborative eliminated write-in reviews from its process. In addition, it pledged to abide by the 50/50 rule: that is, the panel would be completely balanced between panelists looking at the applied science in the proposal (e.g., restoration ecology; institutional barriers to climate change policies, etc.) and panelists looking at the participatory process methods.

Also, I budgeted more time to thoroughly vet the panelists to make sure that they were willing to learn from people outside their discipline. Typically, I would call people who seemed good for the panel and describe what we were trying to achieve. Eventually, I would ask them how they felt about the 50/50 rule and if they understood that a proposal that was good on only one side would be less likely to get funded. In most cases, panelists were fine with the approach, but there have been cases when I have been able to rule out a panelist, because he/she seemed to undervalue the less familiar discipline. Panelists were also asked to participate in every stage of the review process: in our case, three stages. Feedback from panelists has indicated that this long-term commitment is necessary to internalize the goals of the Collaborative.

Our sense of this second year panel as well as the third year panel, which just happened two weeks ago (as of August 2012), is that this is a significantly improved process. Panelists are learning from each other, making specific suggestions on how the two sides (applied science and participatory methods) can be better integrated, and most importantly, catching and fixing typical issues such as: not enough detail on participatory process methods; not enough personnel time/budget allocated to managing the participatory process; and not enough flexibility in the applied science plan to react to user input. In some cases, the problem is that the applicants have gone too far to the side of flexibility and have neglected to put forward any rigorous applied science methods, claiming that this will come out of the stakeholder process. The panel has pointed out that this is fine for a project goal but then it needs to have some rigorous social science methods for doing this kind of needs assessment work.

Feedback from the panel as well as applicants corroborates our sense of these improved review processes. Several panelists have indicated that our process could serve as a model for integrating the natural and human dimension sides of natural resource management problems. At the closing of our recent panel, I held an anonymous voting session, first asking the 11 panelists (one had technical problems and so couldn't participate in the voting exercise) how many other similar panels they had attended. Second, we asked the panelists to rate our panel in comparison to these other panels. Results from this anonymous poll are shown below in Table 36 below. Ideally, these questions would be followed by additional questions to understand why panelists chose the ratings they did. This poll, however, took place at the end of a very long day, and so I decided not to pose any additional queries to the panelists.

Table 36: Showing results from an anonymous poll given to panelists after the Collaborative's Year 3 review panel.

	% of panelists	# of panelists (n = 11)
# of panels served on with similar objectives		
This is the first	18	2
1 or 2	45	5
Between 3 and 5	18	2
More than 5 but less than 10	18	2
More than 10	0	0
Collaborative review process compared w/others		
The best	73	8
Good (Better in many ways, but not as good in some)	18	2
Fair (not as good in many ways, but better in some)	9	1
The worst	0	0

The Collaborative has also received continued suggestions for improving the process. For example, one of the panelists sent in the following comment after the Year 3 panel:

> The proposals that stood out to me were those in which the collaboration and the research are truly complimentary, especially those in which "collaboration people" we're involved in the applied science and the "science people" we're involved in the collaboration activities. It ensures the research and collaboration are in constant communication, and each inform the other throughout the project process. The problem I found was that those situations were pretty rare, and usually dependent on one person who is a member of both teams. So if s/he is exceptional, it all works great...but too much rides on just one person.

This panelist then suggested that we modify the RFP to ask questions that force the applicants to tackle the issues of integration head on: for example, "Please Identify the amount of time funded by the grant that applied research team members spend on activities identified as collaborative in your proposal, and the amount of time collaborative team members spend on activities related to applied research," and

“Please identify the specific techniques and events that will be used to promote communication and collaboration that connects applied science and collaboration team members to ensure efforts are integrated and complimentary.”

While the feedback from panelists and applicants is important, it is equally interesting to note the difference in the final proposals as well as the actual performance of the project teams once they begin the work. I have not yet implemented a rigorous analysis of the changes in proposals over time; however, the Collaborative staff and panelists who have participated in multiple panels agree that the quality of the proposals is increasing. Most noticeably, the proposals have more expertise and resources allocated to the participatory process (Figure 20). For example, two of the seven projects funded under the Year 1 competition had collaboration leads with only two weeks per year on the project. In speaking with these project teams, we have realized that this is far too low to handle the burdens of a truly collaborative and intended user-focused process. In contrast, of the seven projects funded in the Year 2 competition, none of the collaboration leads have less than two months per year on the project, and most have more.

In addition, four of the Year 2 projects have held their initial meetings and the Collaborative has been able to gather preliminary evidence suggesting these meetings have been designed and implemented in a way that meets or exceeds the Collaborative’s expectations. This evidence consists of a mix of direct observation, interviews and a workshop report. The San Francisco Reserve project workshop report (Psaros 2012) uses pictures, tables and text to illustrate the diverse feedback that emerged from the 88 participants who attended the meeting, focused on climate change adaptation. Participants indicated the approach taken by the project would lead to “increased buy-in from stakeholders” and “sounder science to underlie decisions” (Psaros 2012).

For the two cases where the Collaborative was able to directly observe meetings, funding program staff agreed that the meetings matched or exceeded the Collaborative's expectations. After the meeting of the Waquoit Bay Reserve (Massachusetts) project in May, 2012, one of the Marine Biological Laboratory project researchers working on carbon fluxes from wetlands was asked to compare this project experience—so far—with other applied science experiences. He responded:

> I haven't been involved in any project that was so targeted toward end users. This is the first time for me. We have often had to talk about expected use and broader impacts. But that's more general. This is different. It's not expected use. It's real use. For other projects, we always expect and imply use but in this project there's a real stress on actually using the research.

Asked the same question, an employee of the MA Department of Environmental Protection said: "This project experience has been the best…because usually the science research is based upon the funding source so therefore it generates the analysis to respond to what the funder wants to see, compared to what the stakeholders who are not the funders want to see to effectuate the changes that are needed."

Direct observations of the new project beginning in Ohio indicated that the meeting, co-facilitated by the Old Woman Creek Reserve as well as the Consensus Building Institute, most likely increased the credibility, relevance and legitimacy of that project.

Although the Collaborative was unable to directly observe the kick-off meeting for the Mission-Aransas (Texas) project, phone interviews have indicated that the team met funding program expectations with regard to the meeting design and implementation, although this is still preliminary. On the positive side, both the biophysical science lead, Dr. Ed Buskey, as well as the collaboration lead, Dr. Peterson (quoted earlier regarding user diversity) noted how distinctive this process was so far. Dr. Buskey stated:

> I've certainly been involved with other projects that were trying to address resource management issues but none of them have worked with the

> stakeholders in this sort of way. Typically, the way other projects work is we'll go and write our science plan and carry out our science and then we'll meet with stakeholders afterwards and sort of explain what we did and what we found out. So this is certainly a different experience for me: to involve stakeholders and management folks with the process as it's beginning.

Having conducted many of these interviews, I have become prepared for biophysical scientists talking about the newness of a process that engages users much earlier in the research project. I was surprised, however, by Dr. Peterson's comments about the project since she has been working at the interface of science and policy in a much more concerted way for many years. She noted:

> One thing about [the project] that I absolutely love—first time I've ever been on a project like this—our user group can actually make substantive decisions about the science that we're going to conduct. That is so rare. I've been on a couple of projects where our stakeholders actually came up with—we were doing water quality work—they came up with great suggestions for places to sample, but we had to make the commitments of where we were going to sample before in order to demonstrate to the reviewers that we knew what we were doing. With this project—and this is a compliment to you really—it really is open for them to make serious suggestions about where to put current meters. We have some places we know they need to be, but we were given the flexibility to have that open. That is different, very different.

On the negative side we have Peterson's earlier quotation about involving more diverse users. Also, Buskey once again brought up the issue of insufficient time for users to really grapple with the complex concepts being discussed; this emerged as a salient issue in earlier chapters.

In a way, the feedback from both Buskey and Peterson captures the story of this entire dissertation; in general, many interviewees think CICEET and the Collaborative are on the right track. Some go so far as to say that our efforts are a model of how to better link science to decisions. But within the same interview, I hear pointed comments indicating that we can do better: not a little better…a lot better.

Recommendations

Based on the previous chapters, I have developed a list of 10 recommendations for funding programs, like the Collaborative, that are endeavoring to use science to address pressing resource management issues (see Table 37 below). Let me further describe and refine the types of programs that may find these recommendations relevant. To do so, I will borrow the definition of transdisciplinary research given in Haberli et al (2001), as cited in Zierhofer and Burger, 2007; page 68: "Transdisciplinary research involves cooperation among different parts of society and academia in order to address, tangible real-world problems." As noted in Chapter 1, truly addressing complex problems—rather than simply studying them—necessitates the involvement of a diversity of academic disciplines and a diversity of non-academic actors. Bringing this diversity of perspectives to bear in a way that is comfortable and productive is a particularly important aspect of transdisciplinary science.

Table 37: Recommendations for better linking science to decisions.

	Target the Target
1	Be Clear About What You Want, How You'll Get There, And How Those Two Are Connected
2	Put Your Money Where Your Mouth Is
3	Make Sure the Team Roster Matches the Team Goal
4	Get a Ref Who Knows the Rules
5	If You Really Want to Solve Problems, Fund the Problem Definition
	Sharpening the Saw
6	Research the Research
7	Monitor the Duration You've Made Predictions About
8	Contribute to the Education of Tomorrow's Boundary Spanners
9	Delineate a Career Path Specific to Boundary Spanning
10	Participate in a Community of Practice

Target the Target As shown in Table 37 above, the first five recommendations could all be grouped under the heading "target your target." In other words, all five recommendations relate to putting your resources into activities that are central to your fundamental objective, and not relying on proxies and/or assumptions. This echoes Don

Scavia's comment in Chapter 5 that we, as funders, need to: "fund the organizations that are bringing the people together to [identify problems, design research] and have them bring both sides to the table rather than trying to fund people to move into territories they're not comfortable with."

The second set of recommendations, while important, relate more to what Stephen Covey in his book "Seven Habits of Highly Effective People" called "sharpening the saw": that is, activities that are critical for the long-term health and continued high performance of the program and the ideals it stands for.

<u>Recommendation 1: Be Clear About What You Want, How You'll Get There, And How Those Two Are Connected</u> In the book "Structured Decision Making," Gregory et al (2012) make a strong case that many efforts involving science and policy go astray at the outset because they confound fundamental objectives with means objectives. I believe this happened with CICEET, and I believe the Collaborative is slowly unwinding itself from this strategic ambiguity.

A fundamental objective should articulate the desired condition being sought by the program (Gregory et al 2012). For many programs in NOAA, we can borrow from the current "vision" of the agency as noted on its web site: "Resilient ecosystems, communities, and economies." The reader will note that there is nothing in this statement that would necessarily lead to an emphasis on producing more credible science: not unless that is what is explicitly called for to solve the particular problem.

Once the fundamental objective is explicit, the organization can decide on certain "means" objectives. NOAA's means objectives are articulated in its "mission" as "science, service and stewardship." The advantage of clearly separating the fundamental from the means is that one then has the opportunity to reflect on the inherent assumptions that bridge between the two. Let us use the following means objective as an example: "by using science to improve the quality of policies and decisions." Given this means objective, the organization has presumably made a choice to focus on “using science” over “generating science.” These are two very different strategic choices. If you choose the latter of these two options, you are saying that there is some value—yet to be expressed—in the generation of new science. The rationale can be: “Well, I’m at a university and that’s what we do,” or it can be: “When things are done in a science generation mode, it tends to increase the credibility of the work and sets up a constant act and reflect cycle that will result in the best decisions.” These are totally valid but they represent choices and assumptions that need to be made explicit.

Going through this exercise is not necessarily fun or comfortable but it greatly decreases the chances that an organization will rely on unstated assumptions and convention in setting up how it operates to achieve its goal. For example, if one assumes but doesn’t state explicitly that credibility is much more important than relevance or legitimacy (Cash et al 2003), this would lead to a traditional funding approach that focuses on peer review and publications in the most esteemed journals. Yet if the goal of the organization—as it is with NOAA—is to use service, science and stewardship to attain resilient ecosystems, communities and economies, then by focusing most of its resources on credibility alone, the organization has essentially gone off on an unsubstantiated tangent, based on assumptions and convention. Spending money in this way obviously represents a potential waste of finite taxpayer dollars.

Strategic ambiguity and a reliance on unsubstantiated assumptions characterizes CICEET’s early years. Essentially, we were opting out of a critical part of our mission, because the conventional wisdom has been that credible science eventually trickles down to waiting intended users. Recognizing that early on, CICEET began the slow process of actually targeting our target, using our resources to achieve our fundamental objective, instead of using a proxy (credible science) and leaving the rest to chance.

Recommendation 2: After Articulating Your Objectives, Put Your Money Where Your Mouth Is Because many science programs are run by biophysical scientists—like myself, trained as an ecologist—our view of the world resembles those humorous tourist posters one can buy in New York City: a map of the world indicating that the Big Apple covers 70% of the planet. Because of this skewed perspective, perhaps, and also because of strategic assumptions (as discussed above), we tend to assume that science costs a lot, but communication and workshops and participatory processes do not.

Let me use an example to take this point out of the abstract. It is quite common for RFPs to include an explicit criterion around the characteristic of "transferability." In other words, can the research be applied to other areas, other regions, facing similar issues. In the Collaborative's proposal to NOAA, we suggested that while many research projects have aspects that are "transferable," they are usually not "transferred" because no one pays for that to happen. Once again, it is often assumed that someone else will take care of that, or that the scientist will somehow be able to achieve this through publications and attending technical conferences.

As an alternative, the Collaborative is testing an effort to directly support the movement of transferable products from one Collaborative-funded project to other Reserves in the system, sometimes located across the entire country. My colleague, Dolores Leonard, who works on this aspect of the Collaborative full time, can attest to the fact that expecting this kind of transfer to happen without any resources or expertise is an extremely dubious proposition. Yes, some transfer can and will happen on its own, but if we as a society are truly interested in making the most of products that are deemed valuable and transferable, what is the argument for not investing in this transfer? Moreover, I will make the additional point that affecting this transfer requires a demanding and complicated set of skills, as rare and specific as participatory process skills or expertise in geomorphology.

Admittedly, building and maintaining a new satellite is more expensive than communications or the transfer work described above. Moreover, my point is not that every research project should be evenly divided between new science generation costs and knowledge diffusion costs. On the other hand, the previous chapters clearly show that linking science to decisions is critical and difficult. Therefore, logic dictates that achieving this critical part of transdisciplinary research will have its price. Given the importance of some of the issues our nation faces, the famous "Common Law of Business Balance," attributed to the 19th century philosopher, John Ruskin, seems to apply:

> It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money -- that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot -- it can't be done.

<u>Recommendation 3: Make Sure the Team Roster Matches the Team Goal</u> In his book, "Good to Great," Jim Collins (2001) looks at successful companies that were able to survive where their competitors could not. He then tries to draw conclusions and lessons learned from these case studies. One of the resulting chapters is called *"*Get the Right People on the Bus*."* In this chapter, he discusses the importance of having the right people on the team in order to get the job done. In Matso (2012) I quoted one of the collaborative process peer reviewers, who addressed this same principle in the context of a research proposal:

> One thing the [natural science] experts don't think about is that the collaborative process is a skill in and of itself, same way being hydrologist is a skill. Same way you have to scale [the natural science] side, you have to scale the collaborative components. But you need someone who knows what that means in the process.

This again relates to recommendation 1: target your target. If you are truly interested in NOAA's mission of science, service and stewardship, then project teams need to have someone who understands how science links to decisions, traps to avoid, how much it costs, and how to assess when this linkage is happening or not. Moreover, these people must be in positions of power comparable to those who generate the science. Otherwise, the process and results will not reflect the balance articulated in the vision statement.

<u>Recommendation 4: Get a Ref Who Knows the Rules</u> For science agencies, the "ref" is the review process. The Collaborative has seen that the text in the RFPs does affect the proposals. But we have also seen that the RFP can be completely emasculated by a review panel that does not reflect its values. Year 1 of the Collaborative is a case in point. Because we did not have participatory process experts on our final panel, the proposals that were rated best were those with the stronger biophysical science components, even if the participatory process was weak. Why? Because panelists who don't understand what is truly involved in a complex participatory process were impressed by work that would have been called out as being shoddy by an expert.

Further, given mission and vision statements like NOAA, I can see no excuse for giving one kind of panelist (i.e., science generation versus participatory process) more representation on the panel than the other: unless the strategic decisions have already been made and vetted that credibility is more important than relevance or legitimacy. One of the members of the innovative funders focus group suggested that it would be fine to have one participatory process expert on a review panel, but there is no need for equal numbers. I disagree. I have talked to colleagues who have been the "lone social scientist" on panels that were meant to fund proposals that integrate natural and human dimension work. The evidence suggests that this process—which puts one perspective at a considerable disadvantage to another—does not produce results that match the stated intent of the program.

I have also been told by more than one high profile funding agency that they prefer to use decision makers themselves on the panels, rather than participatory process experts. To me, this is yet another slap in the face from one discipline delivered to another. If a decision maker can substitute for a participatory process expert, why can't a decision maker substitute for a hydrologist? Why not just have a panel of decision makers? I believe it makes much more sense to have the decision makers on the project, not the panel.

Recommendation 5: If You Really Want to Solve Problems, Fund the Problem Definition Since this has been dealt with already in this chapter, it requires little elaboration here. Going along with Recommendation 1, the idea here is, once again, that funders shouldn't outsource what is arguably the most critical part of a project. Zierhofer and Burger (2007) studied 16 transdisciplinary projects and noted that one critical advantage of the participatory process—involving scientists and users—was that the scientists, even before the generation of new knowledge began, were able to add additional information to the process.

Some of my colleagues and I have noticed that program managers and/or the people who are charged with assessing the value of funding programs, tend to think of the science process as being similar to a wastewater pipe; the only thing that really matters is what comes out at the end. This narrow, "end-of-pipe" view of research products is partly due to the way that the Government Performance and Results Act of 1994 (GPRA) has been enforced in the public sector: namely, in a bean counter manner that often doesn't capture the worth of a funding organization. Irwin Feller, an expert in government evaluation, put it this way in an article entitled "Performance measurements redux" (2002):

> The informed, nuanced understanding expressed in open forums by senior organizational officials about the limits or complexities of applying performance measurement systems or specific indicators can quickly deteriorate to

> mechanistic, rigid demands by junior examiners, committee staffers, or academic apparatchiks for specific but specious or irrelevant annual metrics.

Yet the previous chapters and reputable studies (e.g., Cash et al 2003; NRC 2009) note that the process itself produces products—such as increased awareness, increased understanding, increased trust. These products tend to be considered irrelevant in GPRA measures and yet all of these indicators are correlated with a society that is more capable of creating resilient communities, as NOAA articulates in its vision.

Critics of a more nuanced approach to project assessment consider increased products like "increased awareness" as lesser "interim" products, rather than final products. NOAA technology transfer personnel, for example, like to focus on "technologies produced" or "salt marsh acres restored." Since CICEET began its years funding innovative technology proposals, I can attest to the fact that there is nothing about something being metal and having fancy buttons that makes it more or less "interim" than a person reporting a change in attitude. Some sensors can change decisions and some sensors are flash in the pans and change nothing. Some marshes are considered restored one year but when the monitoring and upkeep cease, so does the ecosystem functions of those marshes in many cases.

<u>Sharpening the Saw</u> As noted earlier, recommendations six through 10 involve issues that will contribute to the long-term effectiveness of the program. In addition, these recommendations have the potential to impact society in more diffuse ways than through the direct sponsorship of specific projects.

<u>Recommendation 6: Research the Research</u> This dissertation has benefited greatly from earlier work, which has contributed research on research in order to continually improve how we link science to decisions. The work of Cash et al (2003) and NRC 2006 figure most prominently in the previous chapters, but other multi-project studies also provide great insights to program managers (e.g., Leach and Pelkey 2001;

Beierle and Cayford 2002; Ruegg and Feller 2003; Mog 2004; CGIAR 2007; Zierhofer and Burger 2007). In addition, single project case studies (e.g., Cockerill et al 2006; Meyer and Konisky 2007; Torregrosa et al 2010; Pietri et al 2011) allow the researcher to go into greater depth and detail in terms of the challenges and opportunities related to linking science to decisions.

Research on research is needed for the same reason that any intervention requires monitoring. We have to ground truth our mental model, to find out if our prediction of the chain of events has occurred according to our expectations. This sort of research should attempt to obey the same principles of credibility, relevance and legitimacy espoused throughout this dissertation, since there are far too many examples of program evaluations and assessments not producing useable results (NRC 2007a).

One particular option is to use the approach known as “utilization-focused evaluation,” proffered by Michael Patton (1997). According to this paradigm, the evaluation occurs in tandem with the design of the strategy itself and begins as soon as the project begins. The focus of this approach—in contrast with an external evaluation—is that the funding program being assessed is a central partner in the evaluation work. This buy-in and commitment from the funders also leads to greater use of any lessons learned for adaptive management purposes. The NERRS Science Collaborative experience exemplifies how the creation and implementation of a competitive grants process can unfold like an “experiment,” with planned feedback loops for making iterative corrections and adjustments. The adjustments occur not only through the RFP modifications but also in the modification of the review process. Programs considering a similar process would be well served to review the following studies, all of which outline a diversity of methods and rationales for approaching a process-based assessment: (Conley and Moote 2003; CGIAR Science Council 2007; Mandarano 2008; Packard Foundation 2010).

Finally, research on research can be structured to get at some of the questions that emerged as salient in the innovative funder focus group (Chapter 5). Many in the group felt it was important to better understand the organizational as well as individual characteristics of actors involved with linking science to decisions. As noted, this is a central focus of the NSF-funded Sustainability Solutions Initiative in Maine. The rationale is that, in order to better link science to decisions, we need to rigorously study the less obvious characteristics of individuals and institutions that may be preventing us, as a society, from making as much progress in this area as we could.

Recommendation 7: Monitor the Duration You've Made Predictions About Many have questioned the benefits of approaches that emphasize public engagement. Conley and Moote (2003) note that these collaborative approaches have a strong academic and lay following, with an "idealized narrative" that involves the building of social capital and better decisions. At the same time, there are growing critiques of the idealized narrative as well as a specific list of the failings of collaborative approaches, such as: the public interest is not adequately considered; collaborative efforts are co-opted by special interests; and participants question whether it was worth spending significant amounts of time, especially when their perspectives were not found to be in the majority (Conley and Moote 2003). In this context, it becomes very important that funding programs attempting to better link science to decisions set up some framework for ground truthing not only their expectations during the project—stressed above in Recommendation 6—but also their expectations of what will happen after the project is complete.

Tracing the long-term effects of a research project or program is notoriously difficult because change attributed to research projects can take a long time and can also be non-linear (Tornatzky and Fleischer 1990; CGIAR Science Council 2007). Nevertheless, programs should endeavor to produce a humble framework that explains some of the things that they expect will happen after a project is complete and how they will monitor the accuracy of their predictions. Again, this need not be and probably should not be a large percentage of the funding program's expenditures. Also, program managers need not re-invent the wheel. Models exist that can probably be adapted to humble budgets (e.g., CGIAR 2007; Corley 2007). The two works just noted both function by making predictions about the network of people who might hear about research products as well as what impacts the products will have on those people. Phone calls and surveys are then used to verify the predictions.

Without such monitoring, however, the tug of war between proponents and critics of collaborative processes could continue in an inefficient manner. As Conley and Moote (2003) note in their conclusion:

> As proponents of collaborative approaches to resource management, we are unnerved by the ways in which these processes have been portrayed as a cure-all. We are similarly troubled by knee-jerk criticisms of collaborative processes that are based on an opposition to collaboration in principle rather than evaluation of specific processes and outcomes. Thoughtful evaluation of the effectiveness of different collaborative processes is central to understanding what can and cannot be expected of such processes and how they can be integrated with existing institutions.

<u>Recommendation 8: Contribute to the Education of Tomorrow's Boundary Spanners</u> When the Collaborative submitted its proposal to NOAA in 2009, it included a graduate education component called TIDES (Training for the Integration of Decisions and Ecosystem Sciences). Using classroom-based instruction at the University of New Hampshire as well as participation in real-world projects taking place at the Reserves and funded by the Collaborative, this Masters program hopes to prepare some of the future professionals who will be explicitly responsible for linking science and decisions.

Including this educational component in our proposal was controversial as it was certainly not requested in the funding announcement from NOAA. However, based on our observations, we determined that there are not enough people and educational programs focused on linking science to decisions; Susskind and Karl (2008) made a similar observation. Moreover, it seems logical that if we are successful in addressing some or all of the previous recommendations, our society will have a greater need for people who can serve as the bridge between scientists, policy makers and stakeholders.

Finally, while there are many high-quality programs that focus on science and policy issues—e.g., at the University of Washington, Oregon State, University of Rhode Island and Duke University—in most cases the emphasis in these programs is not on the in-the-trenches skills of conflict resolution and participatory process design/evaluation: skills that are required to succeed as a boundary spanner.

<u>Recommendation 9: Delineate a Career Path Specific to Boundary Spanning</u> As one of the focus group participants pointed out, without clear pathways for boundary spanners, any exhortations to better link science to decisions puts "a tremendous amount of pressure on the scientists and other people in this system without the proper incentives at the other end."

For Recommendations 8 and 9, science funders have a special role in addressing this education and career path gap, because they can change the incentives with their allocation of funds. Moreover, they can encourage project teams to use collaborative projects as living laboratories for students and future boundary spanners. Program managers can also attend conferences and champion the importance of boundary spanners as an actor that is distinct from a scientific specialist or a policy analyst or a resource manager. Finally, I should note that addressing any of the first recommendations will also have the affect of helping to establish a distinct role for people trained to link science and decisions.

<u>Recommendation 10: Participate in a Community of Practice</u> As noted in Chapter 5, the notion of a community of practice for funders emerged as an important recommendation from the focus group. This was not a direction I was expecting when I set up the focus group. I have dabbled in some activities that I considered to be

“community of practice” ideas. For example, I participated in the “Research to Application Task Force,” appointed by the Ocean Research and Resources Advisory Panel in 2007. In this and similar activities, I have not been convinced that the time was well spent. Rather, I endeavored to support specific, place-based efforts to link science to decision making, hoping to contribute to a groundswell-fed paradigm shift about how science is designed and implemented.

The rationale from the focus group participants was compelling, however. By combining specific case studies with a community of practice approach, we can better achieve a number of key objectives that build our capacity to link science to decisions, such as: improving review processes; sharing assessment methods; and communicating beyond the choir about the value of new approaches to science implementation.

Questions for Future Research

In laying out the recommendations above, I have also noted several research questions that deserve considerably more attention. The primary research need continues to be more evaluation of collaborative research, as Conley and Moote (2003) urge very eloquently. To better understand the impact of these collaborative approaches, we need diverse evaluations and some of them, at least, need to track the projects for several years after they are completed. Also, my colleagues and I are interested in studying the impacts of our non-research activities, such as communications and/or the work of transferring project findings from one Reserve to another; (the “transfer” work was described earlier in this chapter.)

I am specifically interested in better tracing the expected connections between the users that attend project meetings and the other decision makers that these users then interact with after the meetings are over. Hanna (2000) noted that it was incorrect to assume that the understanding of the research would remain unchanged as one user discussed the meeting with other users who were not present. This is an important question because the process, as the Collaborative currently envisions it, relies on the notion that the knowledge and messages emanating from the meeting move through the social network while maintaining the integrity they had at the beginning. Moreover, this relates to a salient criticism of collaborative approaches: Does the broad public interest truly get represented in processes that often only involve tens of people, rather than hundreds of people (Conley and Moote 2003)?

<u>Walking the Talk With My Research Methods</u> On a more personal level, my immediate plans are to continue doing research on our research, but I want to improve my methods. Specifically, I want to see if I can improve the credibility, relevance and legitimacy of my approach. This was my intent from the beginning; however, in the time crunch of completing all the analyses, the time required to further vet my approach with my intended users received short shrift. As shown in the previous chapters, this is the recurring problem of any research meant to link to decisions; it is difficult to find the time.

It is my hope that I can now reorganize my efforts to address this shortfall. Doing so will no doubt improve flaws I am unaware of as well as flaws I have identified. Regarding identified flaws, there are three aspects of the research I am most eager to improve: analytical clarity; the depth-breadth ratio; and communication of results.

First, let me say a few words about analytical clarity. Through this dissertation, I have learned that I can increase my analytical clarity and still leave the door open to learn unexpected lessons. It took me several iterations of coding the transcripts to realize that I needed a specific organizational framework for my categories, and that this framework needed to represent a clear decision in terms of how I wanted to relate my results. For example, the hypothetical statement, “Scientists don’t really know what problems we managers are facing” can be categorized in many ways—e.g., “funders need to change the culture of academia,” or “scientists need to spend more time learning from managers." Establishing the framework beforehand makes those categorization decisions happen in a much more rational and transparent way.

The framework obviously needs to fit the research questions. I believe those questions and the resulting frameworks need to be set up through discussions between the researcher (me) and the intended users. This would increase the credibility, relevance and legitimacy of the results; also, it would greatly reduce the amount of time I spend struggling with the categorization schemes after the data is collected.

The second issue (the depth-breadth ratio) is related to the issue of analytical specificity. For this dissertation, I erred on the side of asking the interviewees lots of open-ended questions. I remain a fan of the open-ended questions for the purposes of this particular research; however, by spending more time up front piloting my questions and working with intended users, I think I would have arrived at a more focused set of questions. I did conduct pilot tests, but my mistake was not carrying through the pilot analysis all the way to its completion. Rather, I only used the pilot test to get a sense of the quality of my questions. Spending more time on a more thorough pilot test, I believe, would have resulted in fewer questions and a more focused framework. This, in turn, would have allowed me time to interview more users, peruse more documents (e.g., Zierhofer and Burger 2007) and perhaps focus a bit more on the issue of how the scientific information moves through communities of users.

Finally, I look forward to spending more time honing the way I communicate my findings; ironically, failing to truly target communication issues is another one of the shortfalls of many of the projects CICEET and the Collaborative have funded. Others have noted, and this dissertation also shows, that if one does everything else right but then falls short in the way the data is presented and communicated, the science has a much smaller chance of linking to decisions. Currently, this dissertation relies on tables and matrices as its main presentation mode, yet this is only the tip of the tip of the iceberg in terms of the communication tools that are available to me.

Conclusions

In their article on evaluating collaborative resource management, Conley and Moote (2003) call for more and diverse evaluations of science programs. They call for surveys, single case studies and meta-analyses. They also call for building new networks to connect researchers and policymakers. They close by noting:

> Developing truly objective means of evaluating collaborative efforts is impossible. This said, if evaluators make explicit their motives for an evaluation, criteria used and their relative weightings, and data collection methods, we can compare, synthesize, and learn from them. Such synthesis is the next step in addressing the many questions being asked about collaborative resource management.

In designing my research, I did not plan on addressing Conley and Moote's call for future work, but I believe my work actually does address many of the kinds of inquiry they invoke: participatory and process evaluation, a marriage of single and multiple case studies and a foray into creating a community of practice (via the focus group). In this way, I have attempted to synthesize many of the lessons learned by CICEET and the Collaborative as we finish yet another loop in the evolution of our learning and begin to plan our next incarnation as a funding program that effectively links science to decisions.

I am certain that this dissertation will be of value to the Collaborative and to the Estuarine Reserves Division of NOAA; I also hope that this work can be of value to others in the same way that I have learned from previous works, most notably Cash et al (2003) and NRC 2006.

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APPENDICES

APPENDIX A

YEAR 2007 CICEET RFP

Land Use Planning Tools to

Improve Coastal and Environmental Quality

(Subject of Chapter 2)

Cooperative Institute for
Coastal & Estuarine Environmental Technology

Proposal Preparation Guide

Funding Opportunity:

Land Use Planning Tools to
Improve Coastal and Estuarine Environmental Quality

CICEET

FY 2007 Environmental Technology Development Program

October 12, 2006

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

UNIVERSITY of NEW HAMPSHIRE

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Ask Us

Feel free to call CICEET with questions about any aspect of this RFP. Clarifying the requirements of each funding opportunity before you submit will improve your proposal's chance of success.

Mr. Kalle Matso
CICEET Program Manager
T: 603.862.3508
E: kalle.matso@unh.edu

Ms. Justine Stadler
CICEET Project Manager
T: 603.862.2817
E: jstadler@cisunix.unh.edu

The deadline for receipt of your proposal by CICEET is 1 p.m. (1300 hours), EST, on December 18, 2006.

1) About CICEET

The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) develops and applies tools for clean water and healthy coasts nationwide. CICEET is a partnership of the National Oceanic and Atmospheric Administration (NOAA) and the University of New Hampshire (UNH).

As a needs-based organization, CICEET works with coastal resource managers around the country to identify their priority environmental challenges. Then we analyze the obstacles—technical, social, political, and regulatory—that stand in the way of solutions.

If this analysis reveals that new or enhanced technology would help address a problem, CICEET designs a targeted competitive funding opportunity to meet this need. Investigators funded by CICEET must collaborate with the coastal management and regulatory communities to insure that their work stays focused on end user needs.

Tools created through CICEET funding opportunities are made available through training, outreach, and an evolving technology utilization program. CICEET has invested in more than 150 environmental technology development and demonstration projects since its inception in 1997. You can learn more about these projects on CICEET's Project Explorer: http://ciceet.unh.edu

While its administrative offices are located on the UNH campus in Durham, N.H., CICEET sponsors technology development in coastal states nationwide—primarily through its relationship with the National Estuarine Research Reserve System (NERRS). Many projects funded through CICEET are connected to one or more of the 27 NERRS sites or their watersheds.

Learn more about CICEET at http://ciceet.unh.edu

2) About this RFP

The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) invites proposals to its Environmental Technology Development (ETD) Program for funding in FY 2007.

Through this program, CICEET makes strategic investments in the development, demonstration, and application of tools to detect, prevent, and reverse the impacts of coastal pollution and habitat degradation to coastal ecosystems and communities.

This Request for Proposals (RFP) is open to U.S. scientists and innovators from academia, private industry, and the public sector who seek to develop tools that meet the priority needs of coastal management.

Those familiar with CICEET's previous funding opportunities will note that research priorities presented here are more specific than those in the past. This reflects CICEET's new approach to RFP development, one that incorporates an analysis of the technical and non-technical factors that influence coastal management problems.

Research priorities for FY 2008 are under development, and we welcome your input! Please contact us with ideas for research priorities to consider for future RFPs:

Kalle Matso
Program Manager
T: 603.862.3508
E: kalle.matso@unh.edu

3) Funding Opportunity Description

CICEET invites proposals for projects to demonstrate the innovative application of technology for land use planning as a means to improve the quality of coastal and estuarine waters and habitats. Up to $750,000 will be available for this funding opportunity, to be distributed among multiple projects. Proposals may request up to two years of funding.

This funding opportunity has two goals: to enhance the effectiveness of land use planning through the novel application of technologies at the community level; and to promote the broad dissemination of project outcomes to other communities.

Examples of appropriate technologies include geospatial tools, internet-based applications, predictive models, visualization technology, and decision support systems. For this RFP, CICEET defines land use planning as an activity beyond the scale of the individual Best Management Practice (BMP). Examples of land use planning activities that could be influenced by this funding opportunity include the creation or refinement of the following: master plans, conservation guidelines, water resource protection policies, regulatory controls on land use (e.g., ordinances), and site plan review procedures that account for cumulative impacts.

4) Project Elements

CICEET is a needs-based organization. Our mission is to develop and apply effective, accessible tools that address priority environmental challenges identified by coastal resource managers nationwide. In 2006, CICEET conducted an analysis of the technical and non-technical factors that limit the effective use of land use planning tools in support of coastal environmental health. Based on the results of this investigation, CICEET requires that each proposal to this RFP include the following project elements:

- Demonstration of innovative application of land use planning tools;
- Training of municipal-level planners (including volunteers, elected officials and staff) in the relevant technology;
- Demonstration of the target community's commitment to the project's goals, and its readiness to apply project outcomes;
- Partnering with organizations that have an established track record of working with local officials, including the National Estuarine Research Reserve System (NERRS), the Nonpoint Education for Municipal Officials (NEMO), and Sea Grant (Note: CICEET encourages, but does not require, outreach to other groups involved in land use planning, such as developers, architects, and property advocates);
- Inclusion of socioeconomic factors as well as technical and ecological factors in the application of technology;
- *Plan to develop appropriate project performance metrics (including economic implications) to enable adaptive management and effective dissemination;
- *Plan for dissemination activities targeting other municipalities and regions. CICEET encourages, but does not require, outreach to elected officials beyond the geographic scope of the project, and organizations providing resources to local and regional governments, such as the Local Government Commission, National Association of Counties, National Civic League, and the National League of Cities.

*Note: The term "plan" is used for the last two components because CICEET recognizes that the majority of this work may take place after the two-year project duration. Funding for these dissemination activities may be available but is contingent upon project success.

5) Eligibility

This RFP is open to investigators from United States academic institutions, state and local government agencies, non-governmental organizations (NGOs), and the private sector. Researchers from institutions outside the United States may be included as additional investigators, but cannot be principal investigators.

Federal agency personnel—including those from NOAA—are eligible if they can document statutory authority to supplement their appropriations with funds from other federal programs and entities. In some cases, obtaining this documentation can take time, so CICEET encourages such applicants to plan ahead. Federal applicants may not request salary compensation.

In the "Project Elements" section of this funding opportunity, CICEET refers to the requirement that applicants plan to partner with an agency that has an established track record of working with local officials. This does not preclude representatives from such agencies-e.g. NERRS, NEMO, or Sea Grant from applying to this funding opportunity. Private-sector applicants may not include fee or profit in their budget requests.

Please note: CICEET will not accept proposals from CICEET investigators who have failed to submit final reports for completed projects, or progress reports for ongoing work.

6) Technology Transfer

The process of technology development and application is complicated and involves the participation of many essential players: innovators, applied researchers, evaluators, producers, and adopters. We have found that the transfer of technologies into the hands of coastal managers (end users) is most effective when all of these participants are involved—to a certain degree—at all stages of the development and application cycle.

Often, when a CICEET project's funding is complete, work remains to facilitate the technology's or method's application. In cases where researchers have shown a commitment to collaborate with adopters and producers, CICEET may consider investing additional resources to support further development and/or application.

7) Intellectual Property

In some instances, commercialization is the most efficient means of disseminating knowledge or technology. In others case, however, a non-commercial approach may be more appropriate.

Since the dissemination pathway is often not clear at the outset of a project, CICEET strongly suggests that you take the following steps to protect your technology's intellectual property at the proposal stage. By doing this, you will be able to talk freely about your invention and avoid the inadvertent loss of intellectual property rights.

Step 1: Take steps to protect your intellectual property as soon as possible so that you can discuss your research with colleagues in a manner that does not restrict your ability to choose the most appropriate dissemination path. If you receive funding, CICEET will ask you to discuss your research at a meeting with colleagues, coastal managers and industry representatives.

Step 2: Do not make assumptions about the commercialization value of your work. In our experience, researchers often make assumptions about the intellectual property process that are inaccurate.

Step 3: Talk to your institution's Office of Technology Transfer, or its Office of Intellectual Property. Determine the proper approach to intellectual property protection for your technology. This could include any of the following: prior-art research and determination of patentability; pursuit of "confidential and proprietary information"; pursuit of copyright; or no intellectual property protection steps whatsoever. (Note: The title page you download from this site comes with a confidentiality statement. Please review it and contact us with any questions.)

Step 4: Until talking with one of the specialists recommended in Step 3, do not disclose your idea in a public setting. "Disclosure" entails giving enough information—verbally or in written/graphic form—for a person "skilled in the art" to reproduce your invention.

8) Proposal Preparations

CICEET has prepared the following guide to submitting proposals for this funding opportunity. Each proposal must include the following:

A) Title page
B) Abstract
C) Narrative
D) Investigator curriculum vitae
E) Appendix of literature cited
F) Budget forms

A) Title Page

CICEET requires all title pages to be in a standard format. Download the title page template on the CICEET website:

http://ciceet.unh.edu/rfp_2007/rfp_forms.html

B) Abstract

On a separate page, provide a one to two paragraph abstract summarizing the salient points of the proposal, including objectives, methods and expected outcomes.

C) Narrative

Narratives are not to exceed 15 single-spaced pages, with one-inch margins, formatted in "Times" 12-point font. They must include the following elements:

1) Introduction: Briefly describe the land use planning problem your project seeks to address. Explain how your approach would address one or more of the technical or non-technical impediments to land use planning in support of environmental health. Justify the assertion that your approach represents an innovative application of technology. (You will be asked to expand this discussion in the "Methods" section.)

2) Objectives: State your project's objectives and how they relate to the goals of this funding opportunity.

3) Methods: Describe in detail the methods you will use to meet project objectives. Demonstrate how they address each of the "project elements" required by this funding opportunity. Include a timeline for accomplishing your objectives. Expand on the technical aspect of your project and discuss alternatives. Please provide a review of relevant literature and alternative strategies to substantiate how this approach is innovative.

4) Community context: Demonstrate that the community in question has the requisite commitment and resources (data, personnel, legal authority, etc.) to accomplish the objectives of the project. Demonstrate the involvement of local officials at all stages of the project. If it is likely that CICEET funds will leverage support from other sources, please include that information here.

5) Projected outcome: Describe what you see as the projected outcome of the proposed activities. Please discuss how your proposed approach may be applied to other communities. CICEET has a national focus and thus seeks demonstration projects that can serve as templates for use around the country.

6) Roles and responsibilities: Describe the roles and responsibilities of the project participants. Describe who will address the "Project Elements" of this funding opportunity, and why their experience makes them an appropriate choice.

7) Budget justification: Please provide a detailed budget justification that explains each item in your proposed budget. Include a description of any cost-sharing opportunities if applicable.

8) Survey question: CICEET would like to make its extramural research funding competition as user friendly as possible. Your answer will not impact the assessment of your proposal and will help us improve our RFP for future applicants. If you would prefer to submit an anonymous response, we invite you to log on to http://rfp.ciceet.unh.edu/survey.php

On a scale of 1 to 5 (5 being the most favorable score), please rate this RFP document in terms of the following question: Did you have sufficient information and support to prepare your proposal?

Additional comments/suggestions are very welcome!

D) Investigator curriculum vitae

Please limit to two pages.

E) Appendix of literature cited

F) Budget forms

You must submit one budget form for each year of your project, as well as a cumulative form.
See http://ciceet.unh.edu/rfp_2007/rfp_forms.html

9) Submission

The deadline for receipt of your proposal by CICEET is 1 p.m. (1300 hours), EST, on December 18, 2006. Your initial submission MUST be in electronic form, not a hard copy. After the deadline, applicants will be prevented from submitting proposals and will receive an automated reply that CICEET is no longer accepting submissions.

Please send your proposal as a single PDF attachment to an e-mail to submissions@ciceet.unh.edu

If you have questions about converting documents from common formats to PDF, please contact CICEET. Note that proposals in any other digital format will NOT be accepted.

You must also send one signed hard copy of your proposal that includes documentation of your institution's federally negotiated indirect cost rate and contact information for the sponsored research office at your institution. The postmark must not be later than Friday, December 29, 2006. Please mail this to CICEET's Program Coordinator:

Cindy Tufts
Gregg Hall, Suite 130
35 Colovos Road
University of New Hampshire
Durham, NH 03824-3534

You will receive notification of CICEET's proposal evaluations and decisions by early March 2007. Please note that the panel may elect to recommend that a proposal be awarded funds contingent on clarification or changes to the proposal. Please be prepared for this possibility and be ready to respond in early March, 2007. If you have questions regarding the format and guidelines for proposal preparation, please contact CICEET.

10) Evaluation

CICEET will conduct an initial compliance review of all proposals. Proposals deemed "non-compliant" will be eliminated from the competition, and CICEET will notify the applicants as quickly as possible.

Proposals will be deemed "non-compliant" for failure to do one or more of the following:

- Follow the narrative structure outlined above
- Adequately address the questions posed within each narrative component
- Adequately address the required components in the "Project Elements" section
- Follow directions with regard to formatting and submission procedures

Compliant proposals will be reviewed by an expert panel composed of scientists, program managers, and land use professionals from institutions and agencies throughout the United States. Depending on the number of proposals received, CICEET may use external peer reviewers as well.

Please note that projects recommended for funding are subject to a National Environmental Policy Act (NEPA) review regarding the environmental impacts of the proposed research. Funding is contingent upon compliance with NEPA guidelines. Learn more about NEPA: http://www.epa.gov/compliance/nepa

Proposals will be evaluated according to the following criteria:

1) Appropriateness: To what degree are the objectives, methods, and overall approach of the proposal consistent with the goals of CICEET? Did the proposal clearly address the Project Elements stated in this funding opportunity? See "Description" and "Project Elements" sections.

2) Technical Approach: To what extent does the proposal demonstrate excellence in technical capability and familiarity with the issues relevant to land use planning? Does the proposal demonstrate a novel approach to addressing the bottlenecks that currently limit the ability of local planners to improve or protect water and habitat quality? Will the methods allow the applicants to achieve the stated land use planning objectives as well as objectives related to measuring performance and dissemination?

3) Projected Outcome: Based on the proposed activities, what are the anticipated beneficial impacts on water and habitat quality? How transferable is the approach to other coastal/estuarine communities?

4) Personnel: Are the identified personnel qualified for the proposed work, and does the team composition reflect the expertise to address the "Project Elements" described for this funding opportunity?

5) Budget: Is the budget appropriate and justified?

APPENDIX B

YEAR 2009 CICEET RFP

Place-Based Solutions to Land Use and Climate Change Impacts

(Subject of Chapter 3)

FY 2009 Place-based Solutions to Land Use and Climate Change Impacts Funding Opportunity

Full Proposal Guide

January 26, 2009

Cooperative Institute for Coastal and Estuarine Environmental Technology
CICEET

Tools for Clean Water & Healthy Coasts

University of New Hampshire

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Ask Us

Feel free to call CICEET with questions about any aspect of this RFP. Clarifying the requirements of this funding opportunity before you submit will improve your proposal's chance of success.

Mr. Kalle Matso
Program Manager
T: 603.862.3508
E: kalle.matso@unh.edu

Ms. Justine Stadler
Project Manager
T: 603.862.2817
E: justine.stadler@unh.edu

Ms. Cory Riley
ERD Program Specialist
T: 603.862.2813
E: cory.riley@noaa.gov

The deadline for receipt of your full proposal by CICEET is 1 p.m. (1300 hours) EST, on Thursday, March 12, 2009.

More information about this funding opportunity is available at http://ciceet.unh.edu/funding/rfp_2009

The online version has direct links to resources that are not presented in the printed version. CICEET strongly recommends that all potential applicants consult the web pages for this RFP before preparing a full proposal.

I. Request for Full Proposals

Applicants who submit successful preliminary proposals will be invited to submit full proposals to CICEET's pilot FY 2009 Place-based Solutions to Land Use and Climate Change Impacts Funding Opportunity. Approximately $500,000 dollars will be available to fund between two and eight projects of one to two years in duration. This Request for Proposals (RFP) is open to any National Estuarine Research Reserve System (NERRS) staff working in partnership with applicants from the United States academic, private, or public sectors. To be eligible for funding, proposals must name a NERRS staff member as the project's principal investigator or as a co-investigator. Researchers from institutions outside the U.S. may be included as additional investigators, but cannot be principal investigators.

Goals for this RFP

Proposals must address the dual impacts of land use and climate change on coastal resources and communities, as they relate to specific needs that have been identified as priorities by a NERR (or group of NERR sites) and surrounding communities. The following are the goals for this pilot RFP:

A. Fund place-based technology development, refinement, and/or demonstration projects that can be applied to address challenges related to the dual forces of climate change and land use change;

B. Emphasize the use of sound, collaborative practices that facilitate the transfer of research into practical application;

C. Identify ways in which NERRS and CICEET can use the competitive research process to advance mutual goals.

Project Attributes

Projects must develop, refine, and/or demonstrate technologies that address place-based questions or problems related to the dual pressures of land use and climate change. Successful proposals will have the following Project Attributes:

A. Technical: Develop, demonstrate, and/or refine technologies to help solve place-based coastal management challenges related to the dual forces of climate change and land use change;

B. Collaborative: Ensure collaboration between scientists, intended users of the science, and other relevant stakeholders throughout the project;

C. Evaluation/adaptation: Use evaluative tools to improve the project (formative evaluation) and to assess the degree to which the project achieves its anticipated outcomes (summative evaluation);

D. Knowledge Dissemination: Use appropriate, intended user-driven dissemination strategies to ensure that successful technologies and research results are communicated to other NERRS sites and the broader coastal management community.

For this RFP, "technology" is defined as the systematic use of knowledge or tools to better understand or interact with the environment. Examples include engineering designs, best management practices, ideas, instrumentation, protocols, decision support systems, models, and other information-based tools. CICEET welcomes a range of projects, from those focused on the early stages of technology development to those engaged in the demonstration of existing technology.

To promote the application of technology, this RFP emphasizes a collaborative approach to research, one that encourages researchers, intended users of technology, and relevant stakeholders to work together throughout the process of defining a problem and developing methods to address that problem. "Intended users" are defined as those most likely to use the results of the project to better manage natural resources. "Relevant stakeholders" are defined as individuals or organizations that have a direct financial, health, or professional interest in the project's outcomes, and would be instrumental in facilitating or preventing application of the technology.

Intellectual Property Protection

Since the technology dissemination pathway is often not clear at the outset of a project, applicants are encouraged to take steps to protect the intellectual property of ideas at the proposal preparation stage, if appropriate. This will allow you to talk freely about ideas and avoid the inadvertent loss of intellectual property rights. For more information: http://ciceet.unh.edu/funding/rfp_2009/rfp_resources

II. Full Proposal Preparation

Applicants with successful preliminary proposals will be invited to submit a full proposal. CICEET has prepared the following guide to submitting full proposals to this funding opportunity. Please follow the instructions below; full proposals that do not address every narrative requirement in the proper order will be deemed non-compliant and will not undergo further review. Each proposal must include the following components:

A. Title Page
B. Abstract
C. Narrative
D. Literature Cited
E. Qualifications
E. Budget Forms

A. Title Page

CICEET requires all title pages to be in a standard format. The title page template is available online at http://ciceet.unh.edu/funding/rfp_2009/rfp_forms

B. Abstract

On a separate page, provide a one- to two-paragraph abstract summarizing the salient points of your proposal, including a short description of the problem, a brief project overview, anticipated outcome(s), and methods to reach those outcomes.

C. Narrative

Narratives are not to exceed 18 single spaced pages with one-inch margins. They must be formatted in "Times" 12-point font and use CICEET's headings for each section. Narratives must include the following sections in the following order:

1. Problem Statement
2. Project Overview
3. Project Outcome(s)
4. Methods
5. Roles and Responsibilities
6. Transferability
7. NERRS Involvement
8. Timeline
9. Budget Justification

1. Problem Statement

Describe the specific regional or local coastal management problem that your project seeks to address. Describe how this problem is related to the dual forces of changing land use patterns and climate change. Include the location and any relevant natural science (biological, physical, etc.) and social (economic, political, regulatory, etc.) contextual information. Describe existing methods to address the specified coastal management problem. Describe technical and non-technical barriers that prevent existing methods from being applied successfully and explain why improvements are needed (use citations when possible) to overcome these barriers.

Provide citations to support that the problem and barriers to existing methods have been articulated by the coastal management community (reference any papers, workshop proceedings, needs assessments, etc.). Describe how the problem statement or barriers identified in these citations were refined or confirmed with intended users. If refinement and confirmation has not been done, make note of it in this section and provide details on how this will be accomplished in the collaborative section of the methods narrative.

2. Project Overview

Provide a brief overview of the proposed project activities that will contribute to a solution for the problem stated above. Identify whether your proposal is focused on technology development, refinement, and/or demonstration.

3. Project Outcome(s)

Describe the outcome(s) your project is designed to achieve within the one- or two-year project period. Discuss how achieving the short term outcome(s) associated with this project will contribute to a longer term solution to the local land use/climate change problem you have defined. Describe how your project takes into account barriers that prevent existing methods from being successful. Please be focused and realistic about what you plan to accomplish within the one- or two-year scope of your project.

4. Methods

Describe the methods you will use to achieve your project outcome(s). These methods must be organized into the four Project Attribute categories defined below. Justify methods with references to previous experience, citations of previous research results, etc. Given this RFP's emphasis on the collaborative research approach, proposals must explain how intended user and relevant stakeholder input will be incorporated into the described methods. CICEET acknowledges that methods outlined in your proposal may change as a result of the collaborative process. As a result, applicants are encouraged to discuss their approach with intended users and relevant stakeholders as soon as possible, and have a plan for incorporating intended user input into the refinement of this approach. CICEET has provided resources to support the development of methodology for the collaborative process online at http://ciceet.unh.edu/funding/rfp_2009/rfp_resources
The information provided at this link will be used by the technical panel to review the collaborative methods.

A. Technical Methods: Provide a detailed description of technical methods to develop, demonstrate, and/or refine technologies. In your description, include your research design (hypotheses and experimental design), and methods for data management (QA/QC) and analysis/interpretation.

B. Collaborative Methods: Identify and justify an initial list of the types of organizations/individuals you anticipate acting as intended users and relevant stakeholders for your project. Discuss and justify the model you will use to ensure collaboration between investigators, intended users, and relevant stakeholders in 1) problem definition, 2) research design, 3) research implementation, 4) results interpretation, and 5) dissemination of results to intended users and relevant stakeholders.

Your process should allow for a specified team member to use established criteria to assess whether neutral facilitation is required. Describe the structure and frequency of interaction between the aforementioned groups, and how disagreements between participants will be handled.

C. Evaluation/Adaptation Methods: Describe the formative evaluation methods you will use to set targets, monitor progress toward those targets, and make appropriate mid-course corrections to advance your project toward anticipated outcome(s). Describe your summative evaluation plan for determining if you have met your outcomes at the end of the project, including how this information will be tracked and recorded and how the results will be analyzed and reported.

D. Knowledge Dissemination Methods: Describe your plan to disseminate the results of technology demonstration, development, or refinement to the NERRS, intended users, relevant stakeholders, and the broader coastal management community. Dissemination methods should be developed in consultation with intended users at the outset of the project. Include how you will communicate lessons learned from your collaborative process and project assessment and evaluation results to the NERRS, intended users, and relevant stakeholders.

5. Roles and Responsibilities

In this section, describe investigators roles and responsibilities. An investigator may fill more than one role if he or she has demonstrated the necessary experience and it is justified in this narrative. However, the collaborative lead and technical lead cannot be the same person. Any investigator may serve as the Principal Investigator (PI).

Mandatory Investigators:

Identify and justify who will fill the following mandatory investigator roles, and briefly describe their key responsibilities during the project period and the applicable skills and experience that qualify them for the role.

Technical Lead: This person will oversee and coordinate technical aspects of the project. The technical lead cannot be the collaborative lead.

Collaborative Lead: This person will ensure that the perspectives of all investigators, intended users, and relevant stakeholders are represented in the collaborative process and that interactions are handled appropriately. This person will determine when and if interactions between investigators and intended users would benefit from the participation of a neutral facilitator. The collaborative lead cannot also be the technical lead.

Evaluation/adaptation Lead: This person will lead the process to set clear targets, track progress toward those targets, and make any mid-course corrections that are needed as the project progresses. This person is also responsible for developing and implementing a summative evaluation plan and capturing key lessons learned from the project.

Knowledge Dissemination Lead: This person will ensure that intended users and relevant stakeholders have access to any information generated by this project, and that their perspectives on appropriate format and delivery of information are included in the development of dissemination strategies. This person is also a lead on collecting relevant results, evaluation findings, and lessons learned for transferring to other NERRS and coastal managers.

Additional Investigators:

If applicable, identify and justify any additional investigators or subcontractors whose skills are required to achieve your project outcome(s). Please note: Your project will require the participation of intended users and relevant stakeholders as part of your collaborative process. Only mention them in this section if they will be named as investigators, with their time accounted for.

6. Transferability

Describe how the technology or knowledge outcomes of your work could be useful to other NERRS sites and/or the broader coastal community. Discuss the extent to which the problem statement and proposed outcome(s) are applicable beyond your location and situation, and indicate the potential transferability of the results of the research. Include any anticipated changes that might need to be made to apply the technology in another NERR site or coastal community. For this RFP, “transferability” is defined as the degree to which a technology can be applied in more than one place, in more than one situation, or at more than one point in time.

7. NERRS Involvement

Explain why the NERR site(s) you have chosen will be a good platform for conducting this project. Briefly describe the specific site where the project will take place, and if relevant, how the national system will be used to advance the project. Examples include, but are not limited to, the use of existing data or previous research to develop or demonstrate the technology; taking advantage of the range of staff expertise to assist with different aspects of the project; working with multiple Reserves in a region; and using the NERRS network to disseminate results.

8. Timeline

Provide a timeline to achieve your project's anticipated outcome(s), using the timeline form available online at http://ciceet.unh.edu/funding/rfp_2009/rfp_forms.html

This timeline should identify discrete products or activities that signify progress toward anticipated outcome(s). It should reflect the amount of time you will spend on technical, collaborative, evaluative, and knowledge dissemination methods and include sufficient time for data analysis and synthesis, as well as writing semi-annual and final progress reports for the project.

9. Budget Justification

Provide a detailed budget justification that explains each item. Use the budget form available online at ciceet.unh.edu/funding/rfp_2009/rfp_forms.html

Proposals must provide a detailed budget justification for all items in the budget, e.g., salary, equipment, supplies, and travel. Investigators from institutions other than that of the PI must be listed as subcontracts on the budget form and their activities explained in the budget justification. Activities for which you must account include grant administration, technology development and application, data management and analysis, collaborative process activities, adaptive management activities, transfer, communication, and evaluation.

Please note: The following sections–"D," "E," & "F"—are not included in the 18-page narrative limit.

C. Literature Cited

Please include a complete list of all cited work in the proposal.

D. Qualifications

Please include a two-page *curriculum vitae* or résumé for each project team member.

E. Budget Forms

You must submit one budget form for each year of your project, as well as a cumulative form. Please include detailed budgets for subcontractors on a separate budget form. Budget forms are available online at
http:// ciceet.unh.edu/funding/rfp_2009/rfp_forms.html

III. Full Proposal Submission

The deadline for receipt of your proposal by CICEET is 1 p.m. (1300 hours), EST, on Thursday March 12, 2009. Your initial submission MUST be an electronic PDF file, not a hard copy. Proposals sent in any other file format will NOT be accepted. Proposals will not be accepted after the deadline.

Please send your proposal as a single PDF email attachment to submissions@ciceet.unh.edu

You must also send one signed, hard copy of your proposal. The postmark must not be later Thursday, March 12, 2009. Please mail this to CICEET's Program Coordinator:

Cindy Tufts
Gregg Hall, Room 130
35 Colovos Road
Durham, NH 03824

IV. Full Proposal Evaluation

CICEET will conduct an initial compliance review of all proposals. Proposals deemed "non-compliant" will be eliminated from the competition, and CICEET will notify the applicants as quickly as possible. Proposals will be deemed "non compliant" for failure to do one or more of the following:

A. Follow the narrative structure as outlined;

B. Submit all required information for each narrative section, *curriculum vitaes*, budget forms, timeline, etc.

C. Follow directions with regard to formatting and submission procedures.

Each compliant full proposal will be peer-reviewed by at least three experts in the field of the proposed project. CICEET includes a rebuttal process to allow applicants to respond to issues raised by peer reviewers. Applicants will have access to blinded copies of peer reviews and will likely be given five working days for rebuttal. At present, the rebuttals are scheduled to occur between May 4th and May 14th, 2009.

Following peer review and rebuttal, a panel comprised of a multidisciplinary group of intended users, collaborative research experts, and scientists in appropriate disciplines will review full proposals, peer reviews, and applicant rebuttals and make funding recommendations. Applicants will be notified of the outcome of this process by late June 2009.

Please note: projects recommended for funding are subject to National Environmental Policy Act (NEPA) review regarding the environmental impacts of the proposed research. Funding is contingent upon compliance with NEPA guidelines. Learn more about NEPA at http://www.epa.gov/compliance/nepa/.

The panel will evaluate proposals using the following criteria:

1. Problem statement

To what extent is the described problem related to the dual forces of land use and climate change? How well does the proposal make the case that the problem has been articulated by the coastal management community? Does the proposal adequately identify previous and current attempts to address this problem and the technical and non-technical barriers that hinder or prevent effective application of technologies? Has the problem statement been confirmed and/or refined with intended users and relevant stakeholders?

2. Project Outcome(s)

To what extent would achieving the anticipated outcomes help solve the identified problem? How well does the proposal make the case that the project outcomes will take into account technical and nontechnical barriers defined in the problem statement? Are the outcomes focused and realistic given the one- or two-year scope of the project?

3. Methods

To what extent does the proposal include viable, specific, and justified methods for each Project Attribute to achieve the anticipated outcome(s)? How well does the proposal explain how intended user and relevant stakeholder input will be incorporated into described methods? If the problem statement has not been confirmed with intended users and relevant stakeholders does the proposal adequately describe methods to do so?

Technical: To what extent will the methods outlined meet the anticipated outcome(s) related to developing, demonstrating and/or refining technology?

Collaborative: To what extent does the list of potential intended users and relevant stakeholders reflect an understanding of the defined problem? To what extent does the proposal describe appropriate methods for collaboration related to 1) problem definition, 2) research design, 3) research implementation, 4) results interpretation, and 5) dissemination of results to intended users and relevant stakeholders? How well does the porposal describe and justify the collaborative model investigators plan to use?

Evaluation/Adaptation: To what extent does the proposal describe an appropriate plan for formative evaluation, i.e., setting targets and making course corrections? To what extent does the proposal describe an appropriate plan for summative evaluation of the overall project?

Knowledge Dissemination: To what extent does the proposal describe an appropriate, intended user driven plan for knowledge dissemination to intended users and relevant stakeholders beyond the project team?

4. Roles, Responsibilities, and Qualifications

To what extent does each mandatory investigator possess the skills, experience, and qualifications to fill his or her role? If other investigators or contractors were listed, are they adequately qualified to perform the tasks described? Are there other skill sets that should be added to increase the likelihood of meeting project outcome(s)?

5. Transferability

To what extent do the proposed methods and anticipated outcomes have relevance to other NERRS sites or other regions beyond that defined by the proposal? Does the proposal adequately identify modifications that would need to be made to effectively transfer the technology to other sites or regions?

6. NERRS Involvement

To what extent does the proposal make the case that the team of investigators will utilize the distinctive resources and capacity of the NERR System and/or the NERR site(s) where the project will be conducted?

7. Timeline

How realistic is the timeline in terms of completing proposed products and activities within the time frame and scope of the project?

8. Budget Justification

Is the budget appropriate for the work proposed?

V. RFP calendar

Full proposals (by invitation only) due: March 12, 2009
Applicant rebuttal to peer reviews due: May 14, 2009
Notification of funding decisions: June 23, 2009
Funded project start date: Aug 1, 2009

VI. About CICEET

The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) develops and applies technologies to detect, prevent, and reverse the impacts of coastal pollution and habitat degradation nationwide. CICEET is a partnership of the National Oceanic and Atmospheric Administration (NOAA) and the University of New Hampshire (UNH).

As a needs-based organization, CICEET works with coastal resource managers around the country to identify their priority environmental challenges. This analysis forms the basis of competitive funding opportunities that call for projects to develop, demonstrate, and implement technology-based solutions that coastal managers can apply to address these issues. These funding opportunities are designed to ensure a high level of collaboration between intended users of a technology-based solution and the research project team. You can learn more about CICEET's projects on Project Explorer, a searchable online database: http://ciceet.unh.edu.

Since the creation of CICEET in 1997, the National Estuarine Research Reserve System (NERRS) has been an essential partner. As place-based programs, NERRS sites have strong relationships with local communities. At the same time, they are part of a national network through which scientists, educators, and managers in different locations can collaborate strategically to advance common goals. This combination makes Reserves ideal places to develop, refine, test, demonstrate, and disseminate technology that can be applied to improve resource management within the NERRS and the broader coastal management community.

VII. Glossary of Terms

Access: The ability, right, or permission to locate or use a technology.

Application: The use of technology to detect, prevent, or reverse the impacts of pollution and/or habitat degradation on coastal ecosystems and communities.

Collaborative Process: Research that involves interaction between scientists, intended users and stakeholders within a formal and structured process at every stage of the research endeavor including: problem definition, research design, data analysis, connecting data to management implications, and dissemination of results.

Decision Maker: Individuals or organizations that are responsible for selecting a course of action that directly impacts coastal natural resources.

Development (Urban and Agricultural): Human induced landscape alteration resulting in changes to natural systems and subsequent changes in the condition of local water, soil, air, and biota.

Dissemination: The process of sharing technology to ensure that it is accessible to a wider range of coastal managers and technology innovators who can use it to address local problems, or to develop new tools. Dissemination practices include, but are not limited to, workshops, trainings, the distribution of outreach publications and multi media products, peer-reviewed publications, and presentations at conferences.

Effectiveness: The degree to which an activity, technology, process or person has achieved outcomes.

Evaluation: The systematic collection of information about activities, characteristics, and outcomes of projects to make judgments about the project, improve effectiveness, or inform decisions about future programming.

Formative Evaluation: The process by which investigators strengthen or improve the project while it is happening—they help form it by examining the delivery of the program or technology, the quality of its implementation, and the assessment of the organizational context, personnel, procedures, inputs, and so on. Formative evaluations allow a project to make course corrections based on information that is collected during the work period.

Intended Users: Those people targeted by a research project as the people most likely to use the results of the project to better manage natural resources.

Partners: Organizations or individuals who commit to share responsibility for achieving an agreed upon goal and attendant outcomes. All members must dedicate resources to meeting the goal and the partnership should result in outputs such as documents, workshops, funding opportunities, demonstration projects, etc.

Stages of Research: The intellectual phases of a research project, including defining the research question, designing and conducting research, demonstrating or verifying research, communicating results of research to intended users, and/or linking research to policy.

Summative Evaluation: The process by which investigators examine the effects or outcomes of some object at the end of the project—they summarize it by describing what happens subsequent to the project; assessing whether the project can be said to have caused the outcome; determining the overall impact of the causal factor beyond only the immediate target outcomes; and sometimes estimating the relative costs.

Technology: A systematic use of knowledge or tools to better understand or interact with our environment. Engineering designs, best management practices, ideas, instrumentation, protocols, decision support systems, models, and other information-based tools.

Technology Development: The process of identifying a problem and then designing, testing, demonstrating or implementing a technical solution.

APPENDIX C

YEAR 2010 NERRS Science Collaborative RFP

(Subject of Chapter 4)

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SCIENCE COLLABORATIVE FY 2010 FUNDING OPPORTUNITY

REQUEST FOR PROPOSALS & APPLICATION PREPARATION GUIDE

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

UNIVERSITY of NEW HAMPSHIRE

january 29, 2010

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NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

LEARN MORE ABOUT THE NERRS AT NERRS.NOAA.GOV

IMPORTANT NOTE FOR ALL APPLICANTS

Letters of Intent and Full Proposals to the National Estuarine Research Reserve System (NERRS) Science Collaborative FY 2010 Funding Opportunity must demonstrate substantial involvement from NERRS staff. See page 11 of this application package for more information on this requirement.

Contact Us

If you have questions about any aspect of this funding opportunity, please send an email to one of the NERRS Science Collaborative's funding program managers; the use of email enables us to provide consistent answers to questions from all applicants: Kalle Matso, kalle.matso@unh.edu —or— Justine Stadler, justine.stadler@unh.edu

You also may ask questions about this funding program at an upcoming webinar. Logon information for these webinars will be sent by email to NERRS sector listservs in early February:

February 17, 10 AM, EST	March 31, 10 AM, EST	April 1, 10 AM, EST
February 17, 2 PM, EST	March 31, 2 PM, EST	April 1, 2 PM, EST
February 19, 10 AM, EST		

I. About the NERRS Science Collaborative

The National Estuarine Research Reserve System (NERRS) Science Collaborative is a new program, designed to put NERRS-based science to work in coastal communities. Administered by the University of New Hampshire (UNH), this program uses a competitive process to identify, fund, and foster science to address local coastal management problems with broader relevance. Projects selected through annual requests for proposals (RFPs) ensure that researchers and intended users of the science work together to describe science and technology needs related to specific problems, define research questions, design and implement projects using appropriate approaches and methodology, and apply the results. For more about the NERRS Science Collaborative: www.nerrs.noaa.gov/RCDefault.aspx?ID=364

II. Request for Proposals (RFP)

The NERRS Science Collaborative seeks proposals for collaborative, science-based projects to address coastal management problems that have been identified as a priority for a Reserve and a community that it serves. Proposals must relate to at least one of the following focus areas for this RFP:

- Impacts of land use change
- Habitat change and restoration
- Estuarine contamination
- Management of stormwater and nonpoint source pollution

Given that coastal management problems related to these focus areas often are exacerbated by climate change, proposals may take climate change factors into account, as appropriate.

This RFP is open to NERRS staff, working in partnership, if appropriate, with applicants from United States (U.S.) academic, private, or public sectors. A NERRS staff member may be (but does not have to be) the Principal Investigator (PI) on the project. Researchers from institutions outside the U.S. may be included as additional investigators, but cannot be PIs. Federal employees and/or institutions are not eligible to receive funding from a grant awarded by this competition, including funds for travel. However, they may serve as unfunded collaborators on a project.

Approximately $4,500,000 will be available to fund projects. While the Science Collaborative does not place upper or lower limits on proposed budgets, we anticipate that most annual budget requests will range between $100,000 to $300,000, approximately. Proposed projects may be one, two, or three years in duration.

Projects may be anywhere on the research to application spectrum—from earliest stage research to demonstration and implementation—that connects science to decision-making to address a coastal management problem related to at least one RFP focus area. Examples of project results include data to inform best management practices, protocols, instrumentation, engineering designs, decision support systems, educational programs, and other information-based tools.

III. Funding Opportunity Goals

The primary goal of this funding opportunity is to support the development and effective use of science-based tools to make decisions that address coastal management problems related to the focus areas of this RFP. This funding opportunity also seeks to leverage the resources of the NERRS and to build the capacity of Reserves to lead collaborative research projects that engage, as appropriate, scientists, educators, trainers, and intended users of the science to collaboratively define coastal management issues and develop and implement strategies to address those issues.

IV. Collaborative Approach to Science

This RFP seeks projects that use a collaborative approach to increase the likelihood that results of the project will be used to address a specific coastal management problem. By "collaborative approach" we mean one that integrates intended users of the science in the development of the proposal and implementation of the project. When this is done in an explicit way, with the appropriate resources, it can enhance the likelihood that intended users perceive project results as credible, relevant, and legitimate—three qualities that are often required to successfully link science to decision making. More resources on this topic are available in the Collaborative Approach to Science Primer, beginning on page 15. The following terms related to a collaborative approach appear in this document and are clarified here for applicants:

Intended users: Individuals or organizations who are most likely to use the results of the project to address the specified coastal management problem. Depending on the project, this could include those with a direct financial, personal, professional, regulatory, or legal interest in the problem or those who would be instrumental in facilitating or preventing the use of project results.

Credibility: The extent to which the project results are perceived by intended users as meeting acceptable standards of scientific plausibility and technical quality.

Relevance: The extent to which project results are meaningful for—and could be used by—intended users, given the logistical constraints they face, such as budget, level of scientific uncertainty associated with results, and timing of results.

Legitimacy: The extent to which intended users perceive the research process as unbiased and meeting standards of political and procedural fairness.

V. Proprietary Information & Intellectual Property

Disclosure of patentable ideas, trade secrets, and privileged or confidential commercial or financial information may harm an applicant's chances to secure future patents, trademarks, or copyrights. Therefore, proprietary information of this kind should be included in proposals only when it is necessary to convey an understanding of the proposed project.

Applicants must mark proprietary information clearly in the proposal, using appropriate labels, such as, "The following is (proprietary or confidential) information that (name of proposing organization) requests not be released to persons outside the NERRS Science Collaborative, except for purposes of review and evaluation."

Applicants also are encouraged to protect the intellectual property of ideas at the proposal preparation stage, if appropriate. This could allow you to talk freely about ideas and avoid the inadvertent loss of intellectual property rights. More resources on this topic are available on page 19.

VI. Application & Evaluation Process

Step 1: Read the Full Proposal Preparation guide on pages 6–11 and the Collaborative Approach to Science Primer on pages 15–18 of this document. If you have preliminary questions about the NERRS Science Collaborative's goals for this funding opportunity or the types of projects we seek, please contact us by email.

Step 2: Prepare and submit a Letter of Intent (LOI). The Science Collaborative has created a guide to steer you through this process in the next section of this document. LOIs are due by 1 PM EST (1300 hours) on March 1, 2010. Applicants are required to submit a Letter of Intent to be eligible to submit a full proposal.

Step 3: The Science Collaborative will review your Letter of Intent and offer feedback by March 15, 2010. All applicants who submit a complete Letter of Intent will receive feedback, and have the option to submit a full proposal.

Step 4: Develop and submit a full proposal. The deadline for receipt of full proposals by the Science Collaborative is 1 PM EST (1300 hours) on May 6th, 2010.

Step 5: Complete full proposals will be peer reviewed by at least three experts in the field of the proposed project. Applicants will have the opportunity to respond to reviewer comments in the form of a short rebuttal in late June 2010.

Step 6: A multidisciplinary panel of intended users, collaborative research experts, and scientists in appropriate disciplines will review each full proposal, attendant peer reviews, and the rebuttal, and then make recommendations for funding. Applicants will be notified of the outcome of the panel's recommendations via email in early August 2010. Funded projects will begin September 1, 2010.

VII. Letter of Intent Preparation & Submission

Applicants are required to submit a complete Letter of Intent (LOI) to be eligible to submit a full proposal. The LOI's purpose is to provide an opportunity for the Science Collaborative to inform applicants as to whether or not they are on the right track toward development of a competitive full proposal.

The LOI's narrative content is a subset of what you will be required to submit as part of your full proposal narrative. Therefore, in developing your letter, it is important to understand the larger context of this funding opportunity by reading the Full Proposal Preparation guide and the Collaborative Approach to Science Primer in this document.

Please use the Letter of Intent form available at www.nerrs.noaa.gov/RCDefault.aspx?ID=612 to draft your letter. LOIs must address all items listed below in order for applicants to receive feedback and have the option to submit a full proposal. If applicants do not address every narrative component, the Science Collaborative will be unable to offer feedback on the development of a full proposal. LOIs may not exceed four pages (one title page and three narrative pages).

A. Title page (one-page limit) must include the following:

- Project title
- Project Investigator (PI) name, institution, and contact information
- NERRS site(s) involved in the proposal
- Project duration: one, two, or three years
- Estimated total budget for project

B. Letter of Intent Narrative (three-page limit) must include the following:

1. Coastal Management Problem & Approach
Describe the coastal management problem you propose to address and provide evidence for it being a priority issue for the Reserve(s) involved in the proposal. Describe the connection to at least one of the RFP focus areas: impacts of land use change; habitat change and restoration; estuarine contamination; and management of stormwater and nonpoint source pollution. Given that coastal management problems related to these focus areas often are exacerbated by climate change, your description may take climate change factors into account, as appropriate.

2. Project Objectives
State your project's objectives. For the purpose of this RFP, "objective" is defined as an accomplishment essential to addressing the identified problem. This is not intended to be a chronological or comprehensive list of project activities, but an outline of those accomplishments that you anticipate will lead to the most significant results of the project.

3. Intended Users & Anticipated Use
Identify the intended users of project results and justify this choice. It is not necessary to name the intended users in the Letter of Intent. Rather, describe their organization(s) and professional responsibilities. Then describe how the identified intended users will apply the results of this project to make decisions related to the coastal management problem you have identified.

4. Methods
Briefly describe how the information required to accomplish project objectives will be collected and analyzed. Methods can involve social, natural, and/or physical science methodology. See the glossary on page 15 for our definition of social science.

5. Integration of Project Participant Perspectives
Briefly describe how you will integrate the perspectives of project participants, which includes investigators and intended users of project results, throughout the course of the project. See the Collaborative Approach to Science Primer (pages 15–18) for resources on how to respond to this section.

6. NERRS Involvement
Describe how NERRS staff will be involved in the development of the full proposal.

C. Letter of Intent Submission

The deadline to submit your Letter of Intent to the NERRS Science Collaborative is 1 PM EST (13:00 hours) on March 1, 2010. Your LOI must be in the form of one electronic PDF file. LOIs sent in any other file format and those submitted after the submission deadline will not be accepted. Send your Letter of Intent as an email attachment to submissions@nsc.unh.edu. In addition, please send one signed hard copy of your Letter of Intent postmarked no later than March 8, 2010, to the NERRS Science Collaborative's Program Coordinator:

Cindy Tufts
Gregg Hall, Room 130
35 Colovos Road
Durham, NH 03824

D. Feedback Process

The Science Collaborative will provide feedback on all complete Letters of Intent via email on March 15, 2010. This feedback is meant to provide guidance to strengthen the applicant's full proposal. If you decide not to submit a full proposal, please inform the Science Collaborative via email by 5 PM EST (17:00 hours) on March 29, 2010.

The Science Collaborative will provide feedback on LOI narrative components 1 through 6. This feedback will address whether we think a narrative component should be strengthened or clarified in the full proposal. The feedback will consist of one to two sentences that address each component of the narrative. If you are unsure how to address a recommendation we encourage you to re-read the Full Proposal Preparation guide and the Collaborative Approach to Science Primer closely and consult with your team. If you still have questions, please contact us by email.

VIII. Full Proposal Preparation

The following section provides guidance on how to submit a full proposal to this funding opportunity. Please follow the instructions below. Full proposals that do not address every narrative requirement in the proper order, or fail to include any of the required components (A-K), will be deemed "incomplete" and eliminated from the competition. The applicant will be notified. Each proposal must include the following:

A. Title Page
B. Abstract
C. Full Proposal Narrative
D. Budget Justification
E. Letters of Commitment from Intended User(s)
F. Literature Cited
G. Qualifications
H. Budget Forms
I. Reference Map
J. NERRS Reserve Manager Letter of Commitment
K. Checklist of Proposal Components
L. Suggested Reviewers (optional)

FOR GUIDANCE ONLY

For guidance purposes, relevant review criteria will appear in a box like this in each section of the narrative to help applicants understand how reviewers will evaluate that component. A complete list of proposal review criteria is on pages 14–15.

A. Title Page

Title pages must be in a standard format, using the Title form at www.nerrs.noaa.gov/RCDefault.aspx?ID=612

B. Abstract (one-page limit)

On a separate page, provide a one- to two-paragraph abstract summarizing the salient points of your proposal, including a short description of the coastal management problem addressed by your proposal, a brief project overview, anticipated benefits to intended users, and methods to achieve the project's objectives.

C. Full Proposal Narrative (18-page limit)

Narratives are not to exceed 18 single-spaced pages with one-inch margins. Applicants must use the Full Proposal Narrative form at www.nerrs.noaa.gov/RCDefault.aspx?ID=612, which includes the following sections:

1. Coastal Management Problem & Approach
2. Project Objectives
3. Intended Users & Anticipated Use
4. Methods
5. Integration of Project Participant Perspectives
6. Roles & Responsibilities
7. NERRS Involvement
8. Timeline

1. Coastal Management Problem & Approach

Problem Definition
Describe the coastal management problem your project seeks to address. Please provide evidence that the problem you have identified is a priority issue at the Reserve(s) involved in the proposal and the local communities they serve.

Current Approaches to Address the Problem
Describe current approaches to address the defined problem and the most critical barriers that prevent these approaches from successful application. Address research and technology gaps, as well as barriers related to the problem's human dimensions, such as capacity, politics, economics, institutional organizations, and cultural values. Then provide a brief overview of the approach your project would take to address the problem and how it might overcome these barriers. Any detailed steps to develop and implement this approach should be described in the Methods section on page 9.

Addressing an RFP Focus Area
Describe how the coastal management problem you describe is related to at least one of the following focus areas for this RFP: impacts of land use change; habitat change and restoration; estuarine contamination; and management of stormwater and nonpoint source pollution. Given that coastal management problems related to these focus areas often are exacerbated by climate change, your description may take climate change factors into account, as appropriate.

Physical and Social Context 266
Describe the location in which the project will take place. Include relevant natural science (e.g., biological, physical) and social science (e.g., economic, political, regulatory) information.

For guidance only

Relevant review criteria for Coastal Management Problem & Approach section:
To what extent is the coastal management problem described in the proposal appropriate with regard to the stated focus areas for this RFP?

To what extent have the applicants demonstrated that the described problem is a priority issue at the Reserve(s) involved in the proposal and the local communities they serve?

How well does the proposal demonstrate an understanding of the barriers to the successful implementation of current approaches? Does the proposed approach address those barriers?

2. Project Objectives

Please state your project's objectives and describe how they meet the goal of this funding opportunity (page 3). For the purpose of this RFP, "objective" is defined as an accomplishment essential to addressing the described problem. This is not intended to be a chronological or comprehensive list of project activities, rather an outline of your project's most significant objectives.

For guidance only

Review criteria for Project Objectives section
Are the objectives clearly articulated and appropriate to the goals of the RFP?

Are the objectives appropriate to the identified coastal management problem and the duration of the project?

3. Intended Users & Anticipated Use

Intended Users
Please identify the intended users of project results. Justify these choices. It is not necessary to name the intended users in this part of the proposal. Rather, describe their organization(s) and professional responsibilities.

Corroboration of Coastal Management Problem
Describe the steps you have taken before and during the proposal writing process to corroborate your understanding of the identified coastal management problem and the viability of your approach with intended users.

Intended user interactions during the proposal writing process do not have to be formal and could come in the form of one-on-one conversations, workshops, workshop proceedings, existing needs assessments, or reports. Please include citations where appropriate.

Anticipated Use
Describe how the identified intended users will access and use the results of this project to make decisions related to the coastal management problem you have identified.

Be as specific as you can in describing how and when you expect project results to be used. Please include examples that illustrate how this research will benefit intended users.

For guidance only

Relevant review criteria for Intended Users & Anticipated Use section
To what extent do the applicants identify appropriate intended user organizations for the identified problem and proposed approach to addressing it?

Does the proposal include sufficient evidence that the applicants have confirmed their understanding of the nature of the problem and their proposed approach with intended users?

Have applicants clearly shown how project results can be employed by intended users?

4. Methods

Methods can involve social, natural, and/or physical science techniques. See the glossary on page 15 for our definition of social science.

Data Collection and Analysis
Please describe how the data required to accomplish project objectives will be collected and analyzed. Provide a clear description of scientific methods and procedures with enough detail for reviewers to evaluate the technical feasibility and scientific merit of the proposed activities, as well as the suitability of the methods to realize project objectives.

Connecting Findings to Intended User Decisions
Please describe how you will examine the significance of findings and how these findings may support intended user decisions related to the identified problem. Your description should, at a minimum, address how you will examine your initial assumptions and the level of uncertainty related to your approach.

Communication of Results
Please describe and justify the anticipated strategy for communicating (packaging and delivering) project results to organizations represented by the intended users you have identified.

For guidance only

Relevant review criteria for Methods section
To what extent are the methods technically feasible?

To what extent are the methods appropriate to meet the stated objectives?

Do the proposed methods demonstrate appropriate technical capability and familiarity with the scientific subject matter?

Have applicants described an appropriate method to examine the significance of findings, and how these findings may support intended user decisions related to the identified problem?

Have the applicants described an appropriate communications strategy given the problem being addressed?

5. Integration of Project Participant Perspectives

Describe how you will vet critical aspects of the project with all project participants, which includes investigators and intended users of project results. For the purpose of this RFP, “vetting” is defined as the process by which intended users will have prescribed opportunities to ask questions and provide input throughout the span of the project. Vetting should not to be confused with less formal and less extensive efforts to engage intended users that occurred while writing this proposal.

The Science Collaborative recognizes that vetting may lead to changes in the implementation of projects funded by this program. As with any research project, major changes to the research plan or objectives would have to be communicated to the Science Collaborative to amend work plans and address resulting administrative issues.

At a minimum, your description should answer the following questions:

- Which, and approximately how many, project participants will be involved in the vetting process?
- How often will project participants meet throughout the project?
- What kind of ground rules do you anticipate using for decision-making among project participants?
- How will disagreements among project participants be resolved?
- How will input be incorporated at various stages of the project?

For guidance only

Relevant review criteria for Integration of Project Participant Perspectives section:
To what extent are the plans for integration of project participant perspectives feasible?

To what extent are the plans for integration of project participant perspectives appropriate for the coastal management problem to be addressed, as well as for the participants?

To what extent do the proposed plans for integration of project participant perspectives demonstrate capability and familiarity with collaborative methods?

6. Roles & Responsibilities

All proposals must identify investigators who can fulfill the following roles associated with the project:

Principal Investigator (PI)
The PI represents the institution, agency, or friends group that will have overall administrative responsibility for the project. He or she may fill any additional role(s) on the project. Please identify the project PI. Describe their role on the project and the skills and experience that justify your choice.

Integration Lead
The Integration Lead balances the perspectives of the researchers and intended users throughout the project. Considering this person's role in balancing these perspectives, we recommend that he or she be someone other than a researcher or intended user on the project (Jacobs 2002, National Research Council 2006).

Examples of Integration Lead responsibilities include: helping to determine the composition of the project participant group; setting ground rules for group meetings; determining the best method to ensure that all project participants have equal opportunity to provide input (e.g., Will a neutral facilitator be used for meetings?); identifying the best method to ensure that all input is treated equally; evaluating feedback from all project participants; and helping to determine whether mid-course corrections are necessary.

Please identify the Integration Lead on the project. Describe their role on the project and the skills and experience that justify your choice.

Other Investigators
If applicable, identify additional investigators required to meet project objectives. Describe their roles and responsibilities on the project and the experience and skills that make each an appropriate choice.

Intended Users
Please identify a minimum of one intended user of project results who can represent his or her organization throughout 269
the project. Attach a Letter of Commitment from each identified intended user; see page 12 for guidance on this. Intended users may be compensated for their time. While this is not required, it is allowed.

We anticipate that projects will vary in terms of the number of intended users they involve, and that this number will likely change throughout the project. Intended users identified in this section are not necessarily meant to be the only ones who participate in the vetting processes described in "Integration of Intended User Perspectives." Applicants are NOT expected to identify all the intended users that may participate in the vetting processes in this proposal.

For guidance only

Relevant review criteria for Roles & Responsibilities section:
Do the investigators filling the roles listed (PI, other investigators, and Integration Lead) possess the skills, experience, and qualifications to fill their roles?

Are there skill sets missing in terms of meeting the objectives of the project? If so, please describe.

To what extent do the identified intended users have the skills and level of decision-making authority necessary to implement project results?

7. NERRS Involvement

A collaborative approach to science requires a range of skills and expertise. Since most Reserves have staff with expertise in research, decision maker training, education, and stewardship, this RFP is an opportunity to integrate these resources and more effectively link science to decision making. Describe the extent to which NERRS staff (sector leads and others) were engaged in the development of this proposal and any plans to include them in project implementation. This description must be accompanied by a Letter of Commitment from the manager of the Reserve(s) involved in the project; see page 12 for guidance on this.

For guidance only

Relevant review criteria for NERRS Involvement section:
To what extent have applicants engaged staff at participating Reserve(s) in proposal development?

Did applicants include a Letter of Commitment from the manager of each Reserve involved in the proposal?

8. Timeline

Provide a timeline that identifies discrete products and activities that signify progress toward project objectives, using the Timeline form at www.nerrs.noaa.gov/RCDefault.aspx?ID=612

The following sections, "D" through "L", are not included in the 18-page narrative limit.

D. Budget Justification

Provide a detailed budget justification that explains each item in your cumulative Budget form, including salary, tuition, subcontracts, fringe benefits, equipment, supplies, travel, and indirect costs. Describe the time commitment and budget for each person listed in "Roles and Responsibilities." Investigators from institutions other than that of the PI must be listed as subcontractors on the budget form and their activities explained in the budget justification.

For guidance only

Relevant review criteria for Budget Justification section:
Is the budget appropriate for the project's objectives and scope?

Have resources been adequately allocated to all critical components of the proposal?

E. Letters of Commitment from Intended Users

These letters should include a description of the intended user's affiliation and decision-making capacity as it relates to the identified coastal management problem. How will this project increase their capacity, or the capacity of their organization, to address the identified problem? What are they committed to doing on the project? What are their expectations in return for that commitment?

F. Literature Cited

Please include a complete list of all literature cited in the proposal.

G. Qualifications

Please include a *curriculum vitae*, résumé, or professional narrative (maximum length of two pages) for each project participant mentioned in "Roles and Responsibilities."

H. Budget Forms

You must submit one Budget form for each year of your project, as well as a cumulative Budget form. Also, please include a separate, detailed Budget form for each subcontractor labeled "Subcontractor: name of individual and affiliation." A Budget form that can be used for all of these purposes is available at www.nerrs.noaa.gov/RCDefault.aspx?ID=612

I. Reference Map

Please include a reference map of the site and surrounding watershed where the work will take place. The image of the map may not exceed one page. Limit text on this page to the identification of locations and a legend, if applicable.

J. NERRS Reserve Manager Letter of Commitment

Applicants must include a letter from the manager of each Reserve involved in the project. The purpose of the letter is to describe the level of NERRS involvement in the project and to corroborate that the Reserve manager is aware of his or her staff's commitment to achieve the proposed objectives of the project.

This letter is not intended to evaluate the quality of the proposed project. The Science Collaborative requires all Letters of Commitment be in a standard format, a template for which is available at www.nerrs.noaa.gov/RCDefault.aspx?ID=612

K. Checklist of Proposal Components

Please use the Checklist of Proposal Components, available at www.nerrs.noaa.gov/RCDefault.aspx?ID=612, to identify and include all required components of the proposal. Submit your checklist with your proposal. Proposals that do not include all the items on the list will be deemed incomplete and will not undergo further review. Applicants will be notified if proposals are deemed incomplete.

L. Suggested Reviewers (Optional)

You may include a list of reviewers you believe to be especially well qualified to review the proposal. You also may designate individuals you would prefer not review the proposal, indicating why. These suggestions are optional. The Science Collaborative will consider them and may contact you for more information. However, the decision of whether or not to use your suggestions is at the discretion of the Science Collaborative.

IX. Full Proposal Submission

The deadline for receipt of your proposal by the NERRS Science Collaborative is 1 PM EST (1300 hours) on May 6th, 2010. This initial submission must be in the form of one electronic PDF file; proposals sent in any other file format will not be accepted. Please send your proposal as a single PDF file to submissions@nsc.unh.edu.

You must also mail one signed, hard copy of your proposal, postmarked no later than May 13th, 2010. Please mail this to the NERRS Science Collaborative Program Coordinator:

Cindy Tufts
Gregg Hall, Room 130
35 Colovos Road
Durham, NH 03824

X. Full Proposal Evaluation

All full proposals will undergo an initial review to make sure they are complete. Incomplete proposals will be eliminated from the competition without further review and the applicants will be notified. Failure to do one or more of the following will result in a proposal being deemed "incomplete":

- Follow the full proposal narrative structure as outlined;

- Include all required information, such as responses to all sections of the full proposal narrative, *curriculum vitae*, budget forms, letters of commitment, timeline, NERRS manager letters, etc.;

- Follow directions with regard to formatting and submission procedures.

Complete proposals will undergo a written peer review. Peer reviewers will be selected based on their expertise in collaborative research and the specific subject areas of each proposal. Applicants will have the opportunity to read and respond to the peer reviews in the form of a short rebuttal.

Finally, a multidisciplinary panel of intended users, scientists in appropriate disciplines, and collaborative research experts will review each full proposal, attendant peer reviews, and the rebuttal, and then make recommendations for funding to the Science Collaborative.

Projects recommended for funding are subject to National Environmental Policy Act (NEPA) review regarding the environmental impacts of the proposed activities. Funding is contingent upon compliance with NEPA guidelines. Learn more about NEPA at www.epa.gov/compliance/nepa.

Reviewers will evaluate proposals using the criteria on pages 14–15, which will be weighted as follows:

- Coastal Management Problem & Approach, Objectives, Intended Users & Anticipated Use: 15%
- Methods, Integration of Project Participant Perspectives: 50%
- NERRS Involvement: 20%
- Roles & Responsibilities: 10%
- Budget: 5%

Review Criteria

Coastal Management Problem & Approach

To what extent is the coastal management problem described in the proposal appropriate with regard to the stated focus areas for this RFP?

To what extent have applicants demonstrated that the described problem is a priority issue for the Reserve(s) involved in the proposal and the local communities that they serve?

How well does the proposal demonstrate an understanding of the barriers to the successful implementation of current approaches? Does the proposed approach address those barriers?

Project Objectives

Are the objectives clearly articulated and appropriate to the goals of the RFP?

Are the objectives appropriate to the identified coastal management problem and the duration of the project proposed?

Intended Users & Anticipated Use

To what extent do the applicants identify appropriate intended user organizations for the identified problem and proposed approach to addressing it?

Does the proposal include sufficient evidence that applicants have confirmed their understanding of the nature of the problem and their proposed approach with intended users?

Have applicants clearly shown how project results can be employed by intended users?

Methods

To what extent are the methods technically feasible?

To what extent are the methods appropriate to meet the stated objectives?

Do the proposed methods demonstrate appropriate technical capability and familiarity with the scientific subject matter?

Have applicants described an appropriate method to examine the significance of findings, and how these findings may support intended user decisions related to the identified problem?

Have the applicants described an appropriate communications strategy given the problem being addressed?

Integration of Project Participant Perspectives

To what extent are the plans for integration of project participant perspectives feasible?

To what extent are the plans for integration of project participant perspectives appropriate to the coastal management problem to be addressed, as well as to the project participants?

To what extent do the proposed plans for integration of project participant perspectives demonstrate capability and familiarity with collaborative methods?

Roles & Responsibilities

Do the investigators filling the roles of PI, other investigators, and Integration Lead possess the skills, experience, and qualifications to fill their roles?

Are there skill sets missing in terms of meeting the objectives of the project? If so, please describe.

To what extent do the identified intended users have the skills and level of decision making authority necessary to implement project results?

NERRS Involvement

To what extent have applicants engaged staff at participating Reserve(s) in proposal development?

Did applicants include a Letter of Commitment from the manager of each Reserve involved in the proposal?

Budget Justification

Is the budget appropriate for the project's objectives and scope?

Have resources been adequately allocated to all critical components of the proposal?

XI. Glossary of Terms

Collaborative Approach to Science: A process that integrates intended users of the science in the development of the proposal and implementation of the project.

Credibility: The extent to which the project results are perceived by intended users as meeting acceptable standards of scientific plausibility and technical quality.

Decision-Maker: Individuals or organizations that are responsible for selecting a course of action that directly impacts coastal management problems.

Intended users: Individuals or organizations most likely to use the results of the project to address the specified coastal management problem. Depending on the project, this could include those with a direct financial, personal, professional, regulatory, or legal interest in the problem or those who would be instrumental in facilitating or preventing the use of project results.

Legitimacy: The extent to which intended users perceive the research process itself as unbiased and meeting standards of political and procedural fairness.

Relevance: The extent to which the information is meaningful for—and could be used by— intended users, given the logistical constraints they face, such as budget, levels of scientific uncertainty associated with results, and timing of results.

Social Science: The branch of science that studies society and the relationships of individuals within a society. In the environmental context, social science is especially important in understanding the key human participants, the parts they play in the ecosystem, and their specific needs for information (form and content).

Vetting: The process by which intended users have prescribed opportunities to ask questions and provide input throughout the span of a project.

XII. Collaborative Approach to Science Primer

Rationale for the Collaborative Approach

The NERRS Science Collaborative seeks to fund collaborative, science-based projects to address coastal management problems in communities served by NERRS sites.

Our program's dual emphasis on quality science and formal collaborative methods is motivated by a growing body of evidence indicating that if the goal is to link science to decision making, it is not enough to conduct rigorous science (National Research Council (NRC) 1995; Lubchenco 1998; Urban Harbors Institute 2004; United States Commission on Ocean Policy Report (USCOP) 2004; McNie 2007; Dreelin and Rose 2008). At the same time, there is a growing consensus that integrating intended users into the research process enhances the connection of project results to decision making (Cash et al. 2003; Jacobs 2003; NRC 2006).

These conclusions have been corroborated by the experiences of NERRS Science Collaborative staff members, who have managed coastal science funding programs since 1998. We have devoted a significant amount of time studying the impacts and outcomes of projects we have funded and case studies of others. Based on our experience and the literature, we believe that projects with the strongest chance of connecting science to decision making have the following characteristics:

- Investigators involve intended users of project results in the problem at every critical stage of the project;

- The project team has allocated appropriate resources to manage the interactions between investigators and intended users;

- The project team, including subcontractors, has the appropriate expertise to manage interactions and balance perspectives between researchers and intended users.

In our review of projects we have funded, we also heard from project investigators and intended users of their work who believe that funding opportunity programs are in a unique position to encourage the above characteristics. This knowledge informed the design of the NERRS Science Collaborative itself, and its FY 2010 Funding Opportunity.

Given that the use of a formal collaborative approach to the conduct of science may be unfamiliar to some applicants, we have developed this primer as a resource. We encourage anyone with questions about this document or this RFP to contact us by email.

Common Collaborative Approaches

There are several formal collaborative approaches to the conduct of science. The following models have been applied effectively to address coastal management problems. While there are subtle differences to these approaches, all provide explicit mechanisms to integrate a variety of perspectives, including those of project investigators and intended users, at critical stages of the project. You are not obligated to use these approaches in your proposal. Rather, they are provided as examples to illustrate the level of rigor that reviewers will expect you to apply to collaborative processes.

Consensus Building
web.mit.edu/dusp/epp/music/pdf/JFF_KeySteps.pdf

Collaborative Learning Model
oregonstate.edu/instruct/comm440-540/CL2pager.htm

Structured Decision Making
www.structureddecisionmaking.org/steps.htm

Scaling Your Collaborative Approach

The NERRS Science Collaborative expects that the resources and expertise a proposal allocates to collaborative processes will depend on the identified coastal management problem, the project's objectives, the number of intended users, and the funding and time at the applicants' disposal. While the literature indicates that increasing the number of project participants usually increases the utility of research results, we recognize the need to scale collaborative processes so that they are effective and achievable given available resources. As part of that process, applicants will need to determine the number of project participants, how frequently they will interact, and the resources needed to ensure that these interactions meets standards of procedural fairness. It is critical that these questions are answered by someone with experience convening and supervising interactions between researchers and a variety of intended users, i.e., your Integration Lead.

Finding A Qualified Integration Lead

The Integration Lead (described on page 10) provides the important functions of balancing the perspectives of all project participants and ensuring that everyone involved feels the process was as fair as possible. Cash et al. 2002 notes that without "legitimacy"—the trust that the research process adhered to standards of procedural fairness—even the best science often goes unused.

The right person for this role will have experience acting as a bridge between researchers and intended users. Required skills include project management, communication, facilitation, needs assessment, and evaluation. Considering this person's role in balancing researcher and intended user perspectives, we recommend that the Integration Lead not be an intended user or someone engaged in the research (Jacobs 2002, NRC 2006).

It may be that applicants will have access to the right person on staff at the Reserve associated with their proposal. If that is not the case, consider staff from Land Grant or Sea Grant Extension, Non-Point Education for Municipal Officials (NEMO), and the National Estuary Program, or faculty associated with university or college programs.

In addition, below is a list of organizations that provide relevant services. This list was created to provide examples only; the Science Collaborative does not endorse the services of these organizations above others:

• RTI International
Contact: www.rti.org
Molly O'Donovan Dix; 603-672-9051; dix@rti.org

• Consensus Building Institute
Contact: www.cbuilding.org

• RESOLVE
www.resolve.org

• CONCUR, Inc.
www.concurinc.com/index.html

• The Keystone Center
www.keystone.org

Below are links to lists of organizations that may have staff members with the necessary skills for the Integration Lead role.

• conflict.uoregon.edu/resources

• www.lincolninst.edu/subcenters/resolving-land-use-disputes/learn-more/links.asp

Articles that May Prove Helpful

These articles that may be helpful in planning your collaborative approach:

Jacobs, K.L. 2002. *Connecting Science, Policy and Decision-Making: A Handbook for Researchers and Science Agencies*, National Oceanic and Atmospheric Administration, Office of Global Programs, Silver Spring, Maryland.

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, J. Jager, and R.B. Mitchell. 2002. Salience, credibility, legitimacy and boundaries: linking research, assessment and decision making. John F. Kennedy School of Government, Harvard University, Faculty Research Working Paper Series.

Literature Cited in this Primer

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, J. Jager, and R.B. Mitchell. 2002. Salience, credibility, legitimacy and boundaries: linking research, assessment and decision making. John F. Kennedy School of Government, Harvard University, Faculty Research Working Paper Series.

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jager, and R.B. Mitchell. 2003. Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences.* 100:8086-8091.

Dreelin, E.A., J.B. Rose. 2008. Creating a dialogue for effective collaborative decision-making: a case study with Michigan stakeholders. *Journal of Great Lakes Research*. 34:12-22

Jacobs, K.L. 2002. *Connecting Science, Policy and Decision-Making: A Handbook for Researchers and Science Agencies*, National Oceanic and Atmospheric Administration, Office of Global Programs, Silver Spring, Maryland.

Lubchenco, J. 1998. Entering the century of the environment: a new social contract for science. *Science.* 279 (5350): 491 –4976.

McNie, E.C. 2007. Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. *Environmental Science and Policy.* 10: 17-38.

National Research Council (NRC). 1995. Science, Policy and the Coast—Improving Decision Making. National Academies Press, Washington, D.C.

National Research Council (NRC). 2006. Linking knowledge with action for sustainable development: The role of program management—summary of a workshop. Roundtable on Science and Technology for Sustainability. National Academies Press, Washington, D.C.

Urban Harbors Institute. 2004. Improving links between science and coastal management: results of a survey to assess science and technology needs. Draft Report for the Coastal States Organization. www.uhi.umb.edu/pdf_files/FINAL_surveyreport_1004.pdf

U.S. Commission on Ocean Policy (USCOP). 2004. An Ocean Blueprint for the 21st Century. Final report. Washington D.C. http://oceancommission.gov

XIII. More on Intellectual Property Protection

In some instances, commercialization is the most efficient means of disseminating knowledge or technology. In others cases, a non-commercial approach may be more appropriate. Since the dissemination pathway is often not clear at the outset of a project, the NERRS Science Collaborative strongly suggests that you take the following steps to protect your technology's intellectual property at the proposal stage. By doing this, you will be able to talk freely about your invention and avoid the inadvertent loss of intellectual property rights.

Step 1: Take steps to protect your intellectual property as soon as possible so that you can discuss your research with colleagues in a manner that does not restrict your ability to choose the most appropriate dissemination path.

Step 2: Do not make assumptions about the commercialization value of your work. In our experience, researchers often make assumptions about the intellectual property process that are inaccurate.

Step 3: Talk to your institution's Office of Technology Transfer or its Office of Intellectual Property. Determine the proper approach to intellectual property protection for your technology. This discussion could include any of the following topics: prior-art research and determination of patentability; pursuit of "confidential and proprietary information"; pursuit of copyright; or the viability of no intellectual property protection steps whatsoever.

Step 4: The title page you will submit with your proposal comes with a confidentiality statement. Please review it and contact us with any questions.

Step 5: Until talking with one of the specialists recommended in Step 3, do not disclose your idea in a public setting. "Disclosure" entails giving enough information—verbally or in written/graphic form—for a person "skilled in the art" to reproduce your invention.

APPENDIX D

YEAR 2011 NERRS Science Collaborative RFP

(Pertaining to Chapter 6)

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SCIENCE COLLABORATIVE

National Estuarine Research Reserve System Science Collaborative FY 2011 RFP Funding Opportunity

Full Proposal Preparation Guide

Please note: applicants must be invited to submit a full proposal to this funding opportunity.

January 24, 2011

UNIVERSITY of NEW HAMPSHIRE

Questions?

If you have questions about any aspect of this funding opportunity, please send an email to one of the NERRS Science Collaborative's funding program managers; the use of email enables us to provide consistent answers to questions from all applicants:

Kalle Matso,
kalle.matso@unh.edu
—or—
Justine Stadler,
justine.stadler@unh.edu

You also may ask questions about this funding program at an upcoming optional teleconference on February 16 at 2 PM Eastern Standard Time (EST).

Call-in information for this teleconference will be sent via email to NERRS sector listservs in early February 2011.

Important Note

Proposals to the National Estuarine Research Reserve System (NERRS) Science Collaborative's FY 2011 Funding Opportunity must demonstrate substantial involvement from NERRS staff. See pages 6 and 8 of this application package for more information on this requirement.

Table of Contents

University of New Hampshire
National Estuarine Research Reserve System Science Collaborative

I. About the NERRS Science Collaborative

The National Estuarine Research Reserve System (NERRS) Science Collaborative puts NERRS-led science to work in coastal communities. Administered by the University of New Hampshire, this program uses a competitive process to identify, fund, and support science-based projects that address local coastal management problems. Projects are selected through annual requests for proposals designed to ensure that researchers and intended users of the science work together to describe science and technology needs related to specific problems, define research questions, design and implement projects using appropriate approaches and methodology, and apply the results.

For more on the NERRS Science Collaborative: www.nerrs.noaa.gov/RCDefault.aspx?ID=364

II. Request for Proposals (RFP)

The NERRS Science Collaborative seeks proposals for projects that incorporate collaboration and applied science to address a coastal management problem that has been identified as a priority for a Reserve and a community that it serves. By "collaboration," we mean an explicit and justified plan for the interaction of applied science investigators and intended users throughout the project. For information on collaboration that may be helpful in developing your proposal, please read the *Collaboration Primer* that begins on page 12.

Reserves, and the communities they serve, are on the front lines of a changing climate. Shifting rainfall patterns, extreme storms, changing sea and Great Lakes levels, ocean warming and acidification—climate change manifests in many ways along our coasts. Its influences translate into greater risk of drought, fire, and flooding; more frequent storms with the potential to damage infrastructure and threaten human life; and the loss of habitat to support economically important wildlife. As they look to the future, coastal communities need resources to help them consider how they will address existing problems in light of climate change.

Therefore, this RFP seeks to empower Reserves to work with their local communities to address the influences of climate change on a problem related to at least one of the following focus areas: impacts of land use change, habitat change and restoration, management of stormwater, and nonpoint source pollution.

This RFP is open to NERRS staff working in partnership (if appropriate) with applicants from the United States (U.S.) academic, private, or public sectors. Each proposal must designate a fiscal agent who will represent the agency, institution, or friends group that will have overall responsibility for grant/contract administration. A NERRS staff member may be (but does not have to be) the fiscal agent on the project. Researchers from institutions outside the U.S. may be included on the project but cannot serve as the fiscal agent. Researchers from institutions outside the U.S. can only be included in the budget if they meet certain requirements for receiving federal funds. Federal employees and institutions are not eligible to receive funding from this RFP, but they can participate as unfunded project team members.

Approximately $4,300,000 will be available to fund projects. While the Science Collaborative does not place upper or lower limits on proposed budgets, we anticipate that most annual budget requests will range from $100,000 to $300,000. Proposed projects may be one, two, or three years in duration.

III. Project Requirements

Proposed projects may be anywhere on the spectrum that connects science to decision-making—from earliest stage research to demonstration and implementation. Examples of project results include data to inform best management practices, protocols, instrumentation, engineering designs, decision support systems, educational programs, trainings, needs assessments, and other information-based tools.

Proposed projects must fulfill each of the following requirements:

A. Address a coastal management problem that is a priority for a Reserve and a community it serves;

B. Relate to at least one of the following RFP focus areas:
   1. Impacts of land use change
   2. Habitat change and restoration
   3. Management of stormwater
   4. Nonpoint source pollution

C. Address the influence of climate change on the coastal management problem and goals for the project;

D. Demonstrate significant NERRS involvement in proposal development and project implementation;

E. Demonstrate that the project will address the coastal management problem by having the right people use sound science. Therefore, the project must integrate applied science and collaboration.

   We define "applied science" as science that generates practical solutions using knowledge related to natural and/or built systems (biology, geology, chemistry, engineering, etc.), and/or social systems (policy, planning, resource management, sociological, organizational and individual behavior, anthropology, economics, etc.).

   We define "collaboration" as an explicit and justified plan for the interaction of applied science investigators and intended users of the science throughout the project.

For information and resources on collaboration that may be helpful in developing your proposal, please read the *Collaboration Primer* that begins on page 12.

IV. Application & Proposal Evaluation Process

1. Read the *Collaboration Primer* that begins on page 12 of this guide. The primer offers additional information related to collaboration that may be helpful in developing a proposal. If you are applying to this RFP, please don't skip this step.

2. Prepare and submit a preliminary proposal using the guidance in this document. The deadline to submit your preliminary proposal to the Science Collaborative is 1 PM EST (1300 hours) on March 24th, 2011. Guidance for developing a preliminary proposal is available at http://www.nerrs.noaa.gov/RCDefault.aspx?ID=612.

3. Complete preliminary proposals will be reviewed by collaboration experts and applied scientists in appropriate disciplines. Based on the outcome of that review, a subset of preliminary proposal applicants will be invited to submit a full proposal. All applicants will receive feedback from the preliminary proposal review process.
4. Applicants invited to develop full proposals will be notified by May 12th, 2011. The deadline to submit a full proposal is 1 PM on July 14th, 2011. Complete full proposals will undergo a peer review. Applicants will have the opportunity to respond to peer reviews in the form of a short rebuttal in September 2011.
5. A multidisciplinary panel of collaboration experts and applied scientists in appropriate disciplines will review each full proposal, associated peer reviews, and the rebuttal, and then make recommendations for funding. Applicants will be notified of the outcome of the panel's recommendations via email in October 2011.
6. Funded projects will begin in November 2011.

V. Full Proposal Preparation

This section provides guidance on how to submit a full proposal to this funding opportunity. Each proposal must include components A through K (listed below). Appendices will not be accepted. Proposals that fail to include all components A through K will be deemed "incomplete" and eliminated from the competition. The applicants will be notified.

A. Title page
B. Abstract
C. Full proposal narrative
D. Literature cited
E. Reserve manager form
F. Intended user letter of commitment
G. Budget forms
H. Budget justification
I. Qualifications
J. Timeline
K. Reference map

A. Title page

Title pages must be in a standard format. Please use the title page template included in the forms package for this funding opportunity, available at http://www.nerrs.noaa.gov/RCDefault.aspx?ID=612.

B. Abstract (one-page limit)

On a separate page, provide an abstract summarizing the salient points of your proposal. Include a short description of the coastal management problem addressed by your proposal, a brief project overview, anticipated benefits to intended users, and methods to achieve the project's goals.

C. Full proposal narrative (19-page limit)

Full proposal narratives are not to exceed 19, single-spaced pages with one-inch margins formatted in Helvetica 12-point font. This limit includes all charts, graphs, and other images. Full proposals must address narrative requirements one through five in the order provided. Please use the headings below; this will facilitate review of your proposal.

1. Coastal management problem
2. Project overview
3. Roles and responsibilities
4. Collaboration objectives and methods
5. Applied science objectives and methods

1. Coastal management problem

Please address all of the questions below in the order that best suits the flow of your proposal.

- What is the local coastal management problem your project seeks to address?
- How is it related to at least one of this RFP's focus areas?
- How does climate change influence the problem you have described?
- How did you interact with intended users to define the problem?
- Why is addressing this problem a priority for the Reserve and a community it serves? Please cite evidence, such as planning documents, workshop proceedings, needs assessments, NERRS strategic plan, etc.
- What are the current barriers to address the defined problem? Consider research and technology gaps, as well as barriers related to the problem's human dimensions, such as institutional capacity, politics, economics, and cultural values.

2. Project overview

Please address all of the questions below in the order that best suits the flow of your proposal.

- Briefly describe how your project will address the defined problem.
- What are your overall goals for this project?
- How has the influence of climate change on your problem shaped your goals for this project?
- Which organization(s) intend to use the results of your project?
- How do they anticipate using project results in management decisions and actions related to the problem?
- What is the level of involvement of NERRS staff in developing proposal and implementation of the project?

3. Roles and responsibilities

Each project must include the following team member positions:

- Project coordinator
- Fiscal agent
- Collaboration lead
- Applied science investigator(s)
- Intended user(s)

Different people must fill the roles of collaboration lead, applied science investigator(s) and intended user(s). These roles require distinct skills and represent diverse perspectives on the project. However, any team member may fill the roles of project coordinator and fiscal agent as long as they have the appropriate skills and experience for these and any other role(s) assigned.

For each position, please answer the following questions:

- Who will fill it?
- What are their specific responsibilities on the project?
- What are the skills and experience that qualify them for that position?

Project coordinator (mandatory)
Coordinates project activities, acts as liaison between project team members and is accountable to the funder for project results and outcomes. While this position serves as the primary liaison between the project and the Science Collaborative, we reserve the right to communicate with any project team member to ensure that objectives for collaboration and applied science are being met once a project is funded.

Fiscal agent (mandatory)
Represents the agency, institution, or friends group with overall responsibility for grant/contract administration.

Collaboration lead (mandatory)
Leads the development and implementation of an explicit and justified plan for the interaction of applied science investigators and intended users throughout the project. For more information on the characteristics of a collaboration lead, see the *Collaboration Primer* that begins on page 12.

Applied science investigator(s) (mandatory)
Implements applied science methods.

Intended user representative(s) (mandatory)
Provides perspective on need for, and use, of the applied science throughout the duration of the project. The intended user(s) listed here must represent an organization that intends to use the results of the project. Attach a letter of commitment for each intended user named here. See page 8 for guidance. Intended users may be compensated for their time. The intended users identified here are not necessarily meant to be the only ones who participate in your project. Applicants are not expected to identify all of the intended users that may participate in their project.

Additional investigator(s) (optional)
Each project may include additional investigators beyond those required by the Science Collaborative to meet applied science or collaboration objectives. Describe their roles and responsibilities on the project and the skills and experience that qualify them.

4. Collaboration objectives and methods

Please address all of the questions below in the order that best suits the flow of your proposal.

- What are your collaboration objectives for the project? (See the *Collaborative Primer* section on “Creating collaboration objectives” on page 15.)
- How will they contribute to your overall goals for the project?

- What methods will you use to meet your collaboration objectives? (See the *Collaborative Primer* section on "Key characteristics of collaboration methods" on page 16.)
- What is your justification for using these methods? Describe your experience using them under similar circumstances and/or cite literature to support that their use is appropriate for the situation at hand.

5. Applied science objectives and methods

Please address all of the questions below in the order that best suits the flow of your proposal.

- What are your applied science objectives for the project?
- How will they contribute to your overall goals for the project?
- What methods will you use to meet these objectives?
- What is your justification for using these methods? Describe your experience using them under similar circumstances and/or cite literature to support that their use is appropriate for the situation at hand.

The following sections D through K are not included in the 19-page narrative limit. However, they are required supporting information that must be included in your proposal.

D. Literature cited

Please include a complete list of all literature cited in the proposal.

E. Reserve manager form

The Reserve manager must complete and sign the bottom portion of the Reserve manager form submitted with your preliminary proposal. The purpose of the form is to indicate if the level of NERRS involvement has changed in the process of developing the full proposal. This form is not intended to evaluate the quality of the proposed project. Reserve manager forms must be in a standard format. Please use the template included in the forms package for this funding opportunity, available at http://www.nerrs.noaa.gov/RCDefault.aspx?ID=612.

F. Intended user letter of commitment

You must include a letter from each intended user listed in the "Roles and responsibilities" section. The letter must include a description of the intended user's decision-making capacity as it relates to the identified coastal management problem and answers to the following questions: How will this project increase their capacity, or that of their organization, to address the identified problem? What are they committed to doing on the project? What are their expectations in return for that commitment?

G. Budget forms

You must submit one budget form for each year of your project, as well as a cumulative budget form. All project team members (including students) from the fiscal agent's institution should be listed in section A of the budget form. Project team members from institutions other than that of the fiscal agent must be listed as subcontractors in section F. You must also provide a cumulative budget sheet for each subcontractor. Identify the subcontractor budget form as "Subcontractor: name" at the top and use section A for their salary and the salaries of other associates from their institution that are involved in the project. If applicable to your proposal, the budget for supplies and services related to meetings or workshops should be listed under the "expendable supplies and equipment" budget line. Budget forms must be in a standard format, as provided in the forms package available at http://www.nerrs.noaa.gov/RCDefault.aspx?ID=612.

H. Budget justification

Provide a detailed budget justification that explains each item in your cumulative budget form, including salary, tuition, subcontracts, fringe benefits, equipment, supplies, travel, costs associated with implementing applied science and collaboration methods, and indirect costs. Describe the time commitment and budget for each person listed in the "Roles and responsibilities" section of your full proposal. If a project team member is not included in the budget, please describe how he or she will be supported in order to execute their responsibilities on the project.

I. Qualifications

Please include a *curriculum vitae*, résumé, or professional narrative (maximum length of two pages) for each project team member described in the "Roles and responsibilities" section of your full proposal.

J. Timeline

Provide a timeline that identifies discrete products and activities that signify progress toward project goals. Timelines must be in a standard format, as provided in the forms package available at http://www.nerrs.noaa.gov/RCDefault.aspx?ID=612.

K. Reference map (one-page limit)

Please include a reference map of the site and surrounding watershed where the work will take place. The image of the map may not exceed one page. Limit text on this page to the identification of locations and a legend, if applicable.

Providing the following information is optional.

You may include a list of reviewers you believe to be especially well qualified to review the proposal. You also may designate individuals you would prefer not review the proposal, indicating why. These suggestions are optional. The Science Collaborative will consider them and may contact you for more information. However, the decision of whether or not to use your suggestions is at the discretion of the Science Collaborative.

VI. Full Proposal Submission

The deadline for receipt of your full proposal by the NERRS Science Collaborative is 1 PM EST (1300 hours) on July 14th, 2011. Your submission MUST be in the form of a single PDF with a file size of 5 MB or less. Proposals sent in any other file format, or in a larger size, will NOT be accepted. Please send your proposal as a single PDF file to justine.stadler@unh.edu.

You must also mail one signed hard copy of your proposal, (printed double-sided and identical to the electronic version) postmarked no later than July 19, 2011. Please mail this to the NERRS Science Collaborative program coordinator:

Cindy Tufts
Gregg Hall, Suite 130
35 Colovos Road
Durham, NH 03824

VII. Full Proposal Evaluation

All full proposals will undergo an initial review to make sure they are complete. Incomplete proposals will be eliminated from the competition without further review and the applicants will be notified. Failure to do one or more of the following will result in a proposal being deemed incomplete:

- Follow the narrative structure as outlined;
- Include all required information, A through K;
- Follow directions with regard to formatting and submission procedures.

Each complete proposal then will be peer reviewed by two sets of reviewers—one with expertise in collaboration and another with expertise in the applied science described in each proposal. Applicants will have the opportunity to read and respond to the peer reviews in the form of a short rebuttal.

Finally, a multidisciplinary panel of collaboration experts and scientists in appropriate disciplines will review each full proposal, attendant peer reviews, and the rebuttal, and then make recommendations for funding to the Science Collaborative.

Projects recommended for funding are subject to National Environmental Policy Act (NEPA) review regarding the environmental impacts of the proposed activities. Funding is contingent upon compliance with NEPA guidelines. Learn more about NEPA at www.epa.gov/compliance/nepa.

Review criteria

Complete full proposals will be evaluated using the weighted review criteria below. The questions under each weighted criteria category are designated "all reviewers" if both the collaboration and applied science reviewers will respond to the same questions. Otherwise, the questions under the criteria headings are arranged in two sets—one for the collaboration reviewers and one for the applied science reviewers in order to focus each reviewer on the aspects of the proposal that best match their expertise.

1. Coastal management problem (15%)
All reviewers

- Does the problem relate to an RFP focus area and is it a priority for the Reserve and a community that it serves?

- Does the proposal demonstrate that the applicants have adequately considered the influence of climate change on the problem to be addressed?

- Is the problem well described (Consider the problem description, identified barriers to addressing the problem, and how it was defined with intended users.)

2. Project overview (15%)
All reviewers

- Does the proposal demonstrate that the project described will effectively address the problem? (Consider the goals, the organizations that will use results, and how they will use them.)

- Do the project goals adequately reflect the influence of climate change on the problem being addressed?

- Is there significant NERRS involvement? (Consider the description given in this section of the proposal and the Reserve manager form.)

3. Roles and responsibilities (20%)
Collaboration reviewers

- Does the collaboration lead have the skills and experience to carry out their role on the project? (Please consider the collaboration objectives and methods detailed earlier in the proposal.)

- Do the fiscal agent, project coordinator and, if applicable, additional investigators working on collaboration have the skills and experience to fill their roles and contribute to meeting the project goals? Are there skill sets missing?

- Is the intended user(s) on the team appropriate in terms of the described problem and goals for the project?

Applied science reviewers

- Does the applied science investigator(s) have the skills and experience to carry out their role on the project? (Please consider the applied science objectives and methods detailed in the proposal.)

- Do the fiscal agent, project coordinator and, if applicable, additional applied science investigators have the skills and experience to fill their roles and contribute to meeting the project goals? Are there skill sets missing?

- Is the intended user(s) on the team appropriate in terms of the described problem and goals for the project?

4. Objective and methods (40%)
Collaboration reviewers

- Does the proposal demonstrate a strong connection between collaboration objectives and the project goals?

- Does the proposal describe collaboration methods that will be effective in achieving these objectives? (Consider the detail provided on the methods and the related justification.)

- Do the proposed methods demonstrate appropriate technical capability and familiarity with collaboration?

Applied science reviewers

- Does the proposal demonstrate a strong connection between applied science objectives and the project goals?

- Does the proposal describe applied science methods that will be effective in achieving these objectives? (Consider the detail provided on the methods and the related justification.)
- Do the proposed methods demonstrate appropriate technical capability and familiarity with the applied science subject matter?

5. Budget: (10%)
Collaboration reviewers

- Does the budget allocate sufficient funds to meet the project goals? (Please consider the budget allotted to implement collaboration methods and related support for the project team.)

Applied science reviewers

- Does the budget allocate sufficient funds to meet the project goals? (Please consider the budget allotted to implement applied science methods and related support for the project team.)

VIII. Proprietary Information & Intellectual Property

Disclosure of patentable ideas, trade secrets, and privileged or confidential commercial or financial information may harm an applicant's chances to secure future patents, trademarks, or copyrights.

Proprietary information of this kind should be included in proposals only when it is necessary to convey an understanding of the proposed project. Applicants must mark proprietary information clearly in the proposal, using appropriate labels, such as, "The following is (proprietary or confidential) information that (name of proposing organization) requests not be released to persons outside the NERRS Science Collaborative, except for purposes of review and evaluation." In addition, the title page you will submit with your proposal includes a confidentiality statement. Please review it and contact us with questions.

Applicants are encouraged to protect the intellectual property of ideas at the proposal preparation stage, if appropriate. This could allow you to talk freely about ideas and avoid the inadvertent loss of intellectual property rights. If applicable, please consult your institution's technology transfer or intellectual property office to determine the best way to protect your intellectual property.

IX. Collaboration Primer

This primer offers resources related to the integration of collaboration and applied science. Potential applicants may find this primer helpful in developing a proposal to the NERRS Science Collaborative's FY 2011 RFP. This primer is meant as a reference only.

This primer includes the following sections:

A. Why collaboration?
B. Key characteristics of a collaboration lead
C. Creating collaboration objectives
D. Key characteristics of collaboration methods
E. Collaboration resources

A. Why collaboration?

One comment we frequently hear from applicants to our program is "What do you mean we have to collaborate? We already do that!" And in some respects they do. They might be applied scientists embedded in management organizations, or academic scientists who work with their peers in other disciplines, or researchers who educate the general public. Reaching across disciplinary and organizational boundaries is certainly a form of collaboration, and an important one, but at the NERRS Science Collaborative we have a different definition.

By "collaboration," we mean an explicit and justified plan for the interaction of applied scientists and the intended users of science throughout a research project—from the definition of a problem throughout the implementation of that project's results. This definition of collaboration guides our funding opportunities.

Why? Our program is focused on putting NERRS-led science to work in coastal communities, and there is considerable evidence to support the idea that involving intended users throughout the scientific process increases the likelihood that the knowledge being generated will be applied. There are straightforward reasons for this that have been identified through the application and rigorous evaluation of collaboration methodologies:

- Intended users are more aware of the science;
- Science focuses on questions that are a high priority to intended users;
- Science is informed by the knowledge possessed by intended users;
- Science generates knowledge in a way that is practical and useable (e.g., the timing is right, the level of detail is appropriate, economic factors have been considered);
- Intended users trust the science.

Successful collaboration as defined above requires a specific set of skills. To be competitive, your proposal must demonstrate knowledge and skill related to collaboration. Therefore, we encourage applicants to involve the collaboration lead as early as possible in proposal development.

The publications listed below provide more information on collaboration.

Science Policy Assessment and Research on Climate. 2010. *Usable science: A handbook for science policy decision makers.* A Report Published by Science Policy Assessment and Research on Climate. http://cstpr.colorado.edu/sparc/outreach/sparc_handbook/brochure.pdf

National Research Council. (2009). *Informing Decisions in a Changing Climate. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change. Division of Behavioral and Social Sciences and Education.* Washington, DC: The National Academies Press. (Chapter 2 "Effective Decision Support," is most relevant to collaboration methods.) http://www.nap.edu/catalog.php?record_id=12626

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jager, R.B. Mitchell. 2003. Knowledge systems for sustainable development. *Publications of the National Academies of Science*. 100(14): 8086-8091.
http://www.pnas.org/content/100/14/8086.abstract

McNie, E.C. 2007. Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. *Environmental Science and Policy*. 10: 17-38
http://sciencepolicy.colorado.edu/admin/publication_files/resource-2486-2007.03.pdf

B. Key characteristics of a collaboration lead

The NERRS Science Collaborative's FY 2011 RFP requires that all project teams include a collaboration lead. This person is responsible for balancing the perspectives of the applied science investigators and intended users throughout the project. Working with the rest of the project team, they lead the development of the collaboration objectives and the development and implementation of the collaboration methods for meeting those objectives.

The collaboration lead should have the appropriate experience and skill to design and implement collaboration methods that are specific to the coastal management problem to be addressed. However, just as with an applied science investigator, if the collaboration lead does not have all of the specific expertise required for a particular project, other personnel with those skills should be included on the team as additional investigators. For example, a collaboration lead may identify Joint Fact Finding as an appropriate collaboration methodology for a particular project, but they may lack the facilitation skills (or time) necessary to implement certain aspects of it. In that case, the need for facilitation would have to be filled by an additional investigator.

We have compiled examples of the kinds of collaboration skills and knowledge that may be important to have on the project team. These could be possessed by the collaboration lead and/or additional investigators. Please do not consider the following to be a list of skills and knowledge required for all projects—the needs of your project will depend on the problem to be addressed and the intended users involved:

- Familiarity with different collaboration methods/models (See "Key characteristics of collaboration methods" on page 16);
- Needs assessment;
- Setting ground rules for group meetings;
- Determining who will participate in collaboration activities;
- Ensuring that participants have an equal opportunity to provide input;
- Facilitation;
- Evaluation of feedback from participants;
- Working with project team members to integrate feedback into the project;
- Evaluation of progress in meeting collaboration objectives;

- Determining when to make mid-course corrections to better meet collaboration objectives;
- Groups decision making strategies;
- Conflict resolution.

You may be wondering where to find people with the appropriate experience and skills to fill the collaboration lead position for your project. We have observed that people come by this capacity in different ways (just as they do in other sciences).

There are "practitioners" trained to connect science and decision-making around issues and have years of experience in doing so—people like NERRS Coastal Training Program coordinators, Sea Grant and Land Grant Extension staff, and private-sector consultants.

There are also "scholar practitioners"—folks who are trained to both study and implement collaboration methodologies. They are based at universities or colleges, often in departments such as public policy, natural resources, geography, planning, environmental studies, sociology, and sustainability.

C. Creating collaboration objectives

The NERRS Science Collaborative's FY 2011 RFP calls for proposals to include objectives for collaboration that state specifically what you hope to achieve through the integration of applied science investigator and intended user perspectives throughout the project. Collaboration objectives are similar to those you will be creating for the applied science component of your project in one important way—they should link to your project's overall goals and increase the likelihood these goals will be achieved.

Collaboration objectives must be specific to the coastal management problem your team is addressing and the intended users involved. The choice of objectives and how they are scaled to fit the specifics of the project must be determined with the guidance of the collaboration lead and feedback from the rest of the project team. (So bring that person on board as soon as you can!) While there is not a pre-established set of objectives that will fit all proposals, we provide some broad objectives by way of example below:

- The problems, and approaches to addressing them, are jointly defined and created by applied science investigators and intended users. A key component of this is that information users learn from information producers and vice versa.
- The problem definition and research plan is relevant to the particular contexts of intended users.
- The applied science data that are used to define the problem and the applied science data that are generated by the project are viewed as high quality and credible by intended users.

The references below provide more information on collaboration objectives:

Mandarano, L.A. 2008. Evaluating collaborative environmental planning outputs and outcomes: restoring and protecting habitat and the New York-New Jersey Harbor Estuary Program. *Journal of Planning Education and Research*. 27: 456.

Conley, A. and M.A. Moote. 2003. Evaluating collaborative natural resource management. *Society and Natural Resources.* 16: 371-386
http://www.fs.fed.us/emc/nfma/collaborative_processes/conley_moote.pdf

Burgess, J. and J. Chilvers. 2006. Upping the ante: a conceptual framework for designing and evaluating participatory technology assessments. *Science and Public Policy.* 33(10): 713-728. http://www.ingentaconnect.com/content/beech/spp/2006/00000033/00000010/art00002

D. Key characteristics of collaboration methods

The NERRS Science Collaborative's FY 2011 RFP calls for proposals to include collaboration methods that are appropriate for the specific coastal management problem your team is addressing and the intended users involved. As with your collaboration objectives, the choice of methods for collaboration (and how they are scaled to fit your project) must be determined with the guidance of the collaboration lead and feedback from the project team.

The methods also must have enough detail for the collaboration experts reviewing your proposal to be able to assess their validity. Having a detailed description of collaboration methods is essential for your proposal to be competitive. There is no universal list of details that you should use to describe your methodology, but we can offer examples of the kinds of things that should be accounted for in your description:

- A clear and well-supported justification (based on experience and/or relevant literature) for the collaboration methods you have chosen;
- Specific plans for how often project applied science investigators and intended users interact;
- Specific plans for how those interactions will occur. (Who will be involved? How will barriers to effective participation be overcome? Decisions made? Disagreements handled?);
- A plan for how you will evaluate whether you are meeting your collaboration objectives;
- A plan for how resources to support activities associated with collaboration will be allocated; this may be reflected in the budget, personnel on the project, and the timeline*.

*A project that includes collaboration takes longer than a pure applied science project. Based on our experience, most applicants tend to greatly underestimate the amount of time it takes to integrate collaboration into the applied science timeline. We encourage you to keep this in mind as you make decisions about project goals and how to scale collaboration and applied science objectives.

E. Collaboration resources

We have compiled the following list of additional resources on collaboration as a reference for applicants to our FY 2011 RFP.

Publications

Cockerill K., H. Passell, V. Tidwell. 2006. Cooperative modeling: building bridges between science and the public. *Journal of the American Water Resources Association.* 42(2): 457-471.

Jacobs, K.L. (2002) *Connecting Science, Policy and Decision-Making: A Handbook for Researchers and Science Agencies.* National Oceanic and Atmospheric Administration, Office of Global Programs, Silver Spring, Maryland. http://ciceet.unh.edu/resources/jacobs-2002.pdf

Lynam, T., W. de Jong, D. Sheil, T. Kusumanto, K. Evans. 2007. A review of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. *Ecology and Society.* 12(1): 5. http://www.ecologyandsociety.org/vol12/iss1/art5/

Von Korff, Y., P. d'Aquino, K. A. Daniell, and R. Bijlsma. 2010. Designing participation processes for water management and beyond. *Ecology and Society.* 15(3): 1. http://www. ecologyandsociety.org/vol15/iss3/art1/

Zorrilla, P., G. Carmona, Á. De la Hera, C. Varela-Ortega, P. Martínez-Santos, J. Bromley and H. Jorgen Henriksen. 2009. Evaluation of bayesian networks as a tool for participatory water resources management: application to the upper Guadiana basin in Spain. *Ecology and Society*. 15(3): 12. http://www.ecologyandsociety.org/vol15/iss3/art12/

Models of collaboration

The following are examples of collaboration models that have been applied effectively to address coastal management problems. While there are subtle differences between these approaches, all provide explicit mechanisms to integrate a variety of perspectives—including those of applied science investigators and intended users—at critical stages of the project.

This list is just a subset of the models that exist and we provide them by way of example, not endorsement. The collaboration lead (with feedback from the rest of the team) should be able to determine whether one of these or another approach is the best collaboration model for your proposal.

- Consensus Building & Joint Fact Finding
  http://web.mit.edu/dusp/epp/music/pdf/ENV_JF07_JFFarticle.pdf
- Collaborative Learning Model
  oregonstate.edu/instruct/comm440-540/CL2pager.htm
  —or—
  http://ciceet.unh.edu/living_coasts/projects/pdf/CLGuide_11-04-08.pdf
- Structured Decision Making
  www.structureddecisionmaking.org/steps.htm

APPENDIX E

DIRECT OBSERVATION PROTOCAL

(Pertaining to Chapters 3 and 4)

Site/Project Visit
Observation Template

Notetaker: *Kalle Matso*
Date:
Site:
Project Title:
Meeting Title: *?*
Meeting Purpose:

SUMMARY NOTES

Blah blah

<u>Qual/Quant Observations on Project/Meeting</u>

Meeting Venue and Logistics

Was the meeting space/other logistics conducive to a productive and collaborative meeting?

Low (Venue/logistics obviously detrimental to productive and collaborative meeting)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; meeting our hopes and expectations)

Qualitative Examples

Blah blah

Participants/Attendance

Did the number and breadth of participants correspond to the proposal's objectives?

Low (doesn't correspond to the objectives and plan in the proposal)
Medium (some good, some not so good; improvements possible and warranted)
High (right people are there; corresponds well with the plan laid out in the proposal)

Qualitative Examples (also, consider getting a list of participants)

Blah blah

Setting the Stage

Was the agenda clear? Obvious objectives? Ground rules sufficiently clarified?

Low (Agenda and objectives not clear nor discussed. Not conducive to collaboration.)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; appropriately conducive to collaboration.)

Note Appropriate "stage setting" and facilitation will vary from group to group; how well they know each other, etc. This is not an absolute.

Qualitative Examples

Blah blah

Meeting Facilitation

Did the meeting stay on time? Was it always clear what the goals were? Did everyone who wanted to speak get a chance?

Low (Sloppy and somewhat disorganized. Not conducive to collaboration.)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; appropriately conducive to collaboration.)

Qualitative Examples

Blah blah

Blow by Blow Account of Meeting

Blah blah

Overall Assessment of Meeting (scale of 1 to 5, five being highest) Reasons for score.

Blah blah

Changing Levels of Credibility, Relevance, Legitimacy

Did the meeting optimize the opportunity to increase levels for the three attributes above? (Note: Not rating relevance of the research! Rather, rating the ability of the meeting to provide opportunities for making the research more relevant.)

Credibility

Low (doesn't meet the standard we had in mind in writing the RFP)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; meeting our hopes and expectations)

Blah blah

Relevance

Low (doesn't meet the standard we had in mind in writing the RFP)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; meeting our hopes and expectations)

Blah blah

Legitimacy

Low (doesn't meet the standard we had in mind in writing the RFP)
Medium (some good, some not so good; improvements possible and warranted)
High (most if not all good; meeting our hopes and expectations)

Qualitative Examples for Credibility

Blah blah

Qualitative Examples for Relevance

Blah blah

Qualitative Examples for Legitimacy

Blah blah

Other, Misc. Hard To Categorize Thoughts on the Meeting

blah

Conversations/Observations of Other Perspectives on the Meeting

(During and after the meeting, make an effort to chat up an equal number of investigators and users to get their feelings on how the meeting went, why and how they think things might have been improved. Try to get one applied sci investigator and one collab investigator. For the users, try to get people from different perspectives, if possible)

Type the gist of the notes from these conversations here.

- Blah blah

APPENDIX F

FOCUS GROUP SURVEY

(Administered Before Group Discussion)

Focus Group Survey (administered via Survey Monkey)

Page 1: Welcome

Thanks for taking the time to fill out this survey. Please contact me with any questions.

Kalle Matso
kalle.matso@unh.edu
603-781-6591 (cell)

The purpose of this survey is to "prime" our respective pumps for the focus group on Wednesday. In addition, this will provide us all with additional data that may not come out in the 3-hour focus group, and it provides me with additional data that I can use in my PhD chapter dedicated to this focus group.

This survey has ~11 questions--the number depends on your answers--and should take approximately an hour to complete. (This does not include the time it takes to read the preparatory materials, on which the questions are based.)

Ideally, respondents will take this survey with the document "matso-phd-highlights" open for reference. I've also tried to include some of the key information in that document within the survey as well.

You may also find that you will save time by also keeping in mind the points I've asked you to hit in your 10-minute verbal response on May 30th. If you are a "panelist," read the file named "panelist-answers-outline." If you are a "participant" read the file named "participant-answers-outline." Basically, these outlines ask you to be prepared to talk about the objective that is most paramount in better linking science to decisions.

Finally, deciding on how to better link science to decisions is a complex topic. Sometimes, we may feel a little "lost." An effective focus group technique is to establish a "home base" to recall the purpose of the focus group. Our purpose is written on the first page of the "matso-phd-highlights" document and is also written below. Please return to "home base" whenever you need to.

HOME BASE
Learn about what different innovative funders are doing and learning as they try to better connect science with decisions. Specifically, what funder practices are most important in linking science with decisions? And what more could each of us do to improve how much of our science links to decisions?(Note: The emphasis on this event is not on consensus, nor on decision making. Rather, the goal of the meeting is to learn from each other. The next step (for another event) will be to synopsize what we learn and propose appropriate actions.

In accordance with the purpose as stated above. please do not feel that your answers should characterize other funding programs. Instead, answer in terms of your program and your experience.

Thanks.

Page 2

Q1: What is your name?

Page 3: Choosing the most critical three of the six Means Objectives:

This part of the survey deals with ideas for "Means" Objectives--objectives that focus on HOW to achieve something--in order to better link science with decisions. For each means objective, there are associated Best Practices that are more specifically articulated actions for funders.

This material is summarized on Page 9 of the "highlights" document and is derived from all the research results, summarized on pages 4 through 8. Pages 1 through 3 of the "highlights" document offer some general assumptions and context for answering these questions.

If you haven't read this document, you may want to do so before answering these questions. Thanks.

(To get a sense of the actual testimony that led to the creation of these objectives, please scan the PhD chapters themselves.)

(Remember: Please answer in terms of your program; I am not asking you to make statements about other programs.)

Q1: Please select the most critical objectives for better linking science to decisions (no more than three). Please note on a separate piece of paper which objectives you choose as you'll be asked to answer follow-up questions on only those three objectives.

Use text box to add additional objectives and Best Practices for that new objective. You will be able to modify the existing Objectives and Best Practices later in the survey.

Page 4: Questions regarding Means Objective 1 and Associated Best Practice Suggestions:

Means Objective 1 has three Best Practices. (Best Practices are specific actions that funders can take to better link science to decisions.)

You may skip to Page 5 if Objective 1 was not one of the three objectives you deemed most critical. (Even if you did not select this objective as one of your three most critical, you may still offer comments on this objective or the way it is worded.)

Q1: Please comment or make modifications to Means Objective 1 below. If left blank, I will assume you are satisfied with the way this objective is articulated.

Strongly agree, Agree, Disagree, Strongly Disagree

Q2: Best Practice 1: Please select the response that best reflects your view on the following suggestion. (You will have the chance to add additional Best Practices for this objective later in the survey.)

Strongly agree, Agree, Disagree, Strongly Disagree

Q3: Best Practice 2: Please select the response that best reflects your view on the following suggestion.

Strongly agree, Agree, Disagree, Strongly Disagree

Q4: Best Practice 3: Please select the response that best reflects your view on the following suggestion.

Strongly agree, Agree, Disagree, Strongly Disagree

Q5: If applicable, please add any additional Best Practices specific to Objective 1.

(Pages 5 through 9…..Same questions asked for Objectives 2 through 6 and Best Practices 4 through 10)

Final Page:

Q1: Please use this space for any questions or comments regarding any aspect of this survey and/or the research itself. Thank you.

APPENDIX G

FOCUS GROUP MATERIALS

“HIGHLIGHTS” DOCUMENT

Innovative Funder Focus Group -- Pre-Event Materials
General Overview

Purpose As funders and as a society, improve our ability to link science to decisions.

Means Learn about what different innovative funders are doing and learning as they try to better connect science with decisions. Specifically, what funder practices are most important in linking science with decisions? And what more could each of us do to improve how much of our science links to decisions? *(Note: The emphasis on this event is not on consensus, nor on decision making. Rather, the goal of the meeting is to learn from each other. The next step (for another event) will be to synopsize what we learn and propose appropriate actions.*

Getting on the Same Page

- Defining Science: By the term "science" we refer to a systematic effort to acquire reliable knowledge about the world. This includes work to better understand non-human phenomena (e.g., water chemistry, estuarine habitats, effectiveness of tide gates, decision support systems, climate change models, educational curricula, etc.) as well as the human dimension (e.g., individual or organizational behavior.

- Defining Decisions: By the term "decisions," we refer to a broad class of actions (from understanding the research to adopting the research) by a broad class of actors (e.g., citizenry, non-profits, governments at various scales) because natural resource management policy issues almost always involve a broad set of users. In other words, since we are particularly interested in linking science to decisions, it is a specific requirement of this research to consider a less narrow definition of decisions and decision makers.

- Kind of Research We're Focusing on: We are interested in that segment of research that is funded with the expectation of trying to address a pressing natural resource problem in a timely manner (e.g., while the research is happening or within a few years after completion).

    - We acknowledge that society benefits from many different kinds of research and that this kind of research is only one option.
    - We also acknowledge that the best practices suggested here are specific to useable science and may not be appropriate for other kinds of science.

- Discussion Focus and Tone: This day's conversation is about discussing some Best Practices that are worthy for consideration and further testing. There is a whole separate and future conversation related to constraints that may make some of these Best Practices hard to actualize. This is an important topics but one that is more appropriate for a future day. Therefore, our intent is to focus on good ideas that could lead to better linking of science to decisions. Later, we'll talk about challenges, etc.

Case Studies Overview

Summary This research involves five different competitive grants processes beginning 2007, 2009, 2010, 2011 and 2012. Most of the focus is on the first three Requests for Proposals (RFPs). The 2007 and 2009 RFPs were sponsored by CICEET and the rest by the NERRS Science Collaborative.

RFP Changes Over Time

- <u># of Projects, Durations, Budgets</u>: All projects funded for the first three RFPs are two years in duration. The others are 3-year projects. The number of projects funded and average *annual* budgets are: 2007 (13 projects*, $112K); 2009 (4 projects, $119K); 2010 (7 projects**, 233K); 2011 (7 projects, 292K); 2012 (still in process).

- <u>Overall Project Structure:</u> The RFPs include straight-to-full-proposal; Letters of Intent followed by Full Proposal; and Preliminary Proposal followed by Full Proposal. The overall trend has been to allow for more and more iteration since this kind of collaborative research has proved challenging for many applicants.

- <u>Required Methods</u>: The RFPs began in the mode of many applied research programs, in which funders ask applicants to talk generally about how they will connect science to decisions. The most recent RFPs, however, attempt to treat methods for linking science to decisions exactly the same as the methods for the science itself.

- <u>Required Expertise</u>: Similar to methods (see above), the RFPs have trended towards asking for more and more demonstrable expertise with regard to linking science to decisions. The most recent RFP includes a “primer” with information on how and where to find these experts.

- <u>Review Personnel</u>: This aspect may have seen the most significant and impactful changes. With earlier RFPs, we tried to find review personnel who were strong in both biophysical and “outreach/extension” work. Now, these are completely separated. Each proposal is read by two reviewers expert in the science that is being generated (e.g., salt marsh restoration; human dimension barriers to using climate change models) as well as two reviewers who expert in collaborative or participatory processes (i.e., linking science to decisions).

- <u>Post-Award Activities:</u> Beginning with the 2010 RFP—which introduced numerous requirements that were challenging to applicants—we have devoted more time to outreach and “consulting” with regard to the collaborative research model.

* Only 3 of the 13 projects were studied for this research
** Only 6 of the 7 projects were studied for this research

Methods Overview

- Case Study Approach: Case studies are appropriate for situations when the inquiry involves "how" or "why" questions, is deeply embedded in a real-life context and when the phenomenon of interest has multiple variables, many of which are unknown to the researcher at the outset of the work.

- Strengths of Multiple Case Study Approach: As opposed to a single case study, the multiple case study provides an opportunity to discover findings that extend across contexts of specific projects; these findings then can be seen as more compelling. (The trade-off is that one cannot burrow as deeply as one can in a single case study.)

  Case studies can either be quantitative or qualitative or a mix of the two. This study is qualitative.

- Qualitative Analysis: Qualitative methods do not pre-suppose specific relationships between sets of variables associated with the phenomenon of interest. The approach strives to be open, flexible and iterative. That is, relationships and patterns are noted and then the researcher returns again to the data—or collects more data—to strengthen the emerging explanation of why a certain phenomenon has occurred in a certain way. This flexibility, however, creates the needs for procedures to ensure rigor. (see below)

- Data Collection/Analysis: Semi-structured interview format used for all interviews, which were then transcribed and then organized and analyzed using NVIVO 9.0, an industry-standard software package for qualitative inquiry. NVIVO allows for each section of an interview to be labeled and categorized, which serves to decrease bias and increase rigor.

  Claims regarding causation are made based on a "weight of evidence" approach, strengthened by making pains to collect data from multiple perspectives. This in contrast to quantitative approaches, which usually rely on statistical analyses.

2007 RFP Case Study Findings

Background (for details, see PhD Chapter 2)

- RFP titled "Land Use Planning Tools" called for innovative application of land use planning tools. RFP asked that projects include a training component (targeted to planners), and dissemination of information to intended users. RFP stipulated that applicants needed to demonstrate that they were working with a municipality that was ready, willing and able to work with applicants on the project.
- Received over 30 proposals. Panelists came from a range of backgrounds. Most panelists were strongest in biophysical aspects applying land use tools.
- Thirteen 2-year projects were funded. The projects began in the Fall of 2007 and were completed in 2010.

Methods

- Interviewed two investigators and two intended users from each of four projects. Questions focused on trends in linking science to decisions; descriptions of how investigators and users worked together on the project; and critical factors in optimizing how much science is linked to decisions.

Results

- Two of the three projects met expectations regarding linking science to decisions, and all three projects felt that the linkage could have been increased with improvements in the process.

- All three case studies converged on the ideas below. Funders need to:

    - Use leverage to get investigators and users to work together more before and during the project.
    - Set aside more money and more time for user involvement.
    - Maintain the credibility of the research throughout.
        - Note that user involvement was not seen as being at tension with credibility; rather, user involvement was seen as being at tension with a quickly moving process.

Main Conclusions

- Credible research and rigorous user involvement are both necessary and insufficient (on their own) for linking science to decisions.
- Funders request same level of rigor for science linking methods as for science generation methods.

2009 RFP Case Study Findings

Background (for details, see PhD Chapter 3)

- RFP titled "Place-Based Solutions to Land Use and Climate Change Impacts" called for science activities addressing dual impacts of land use and climate change on coastal resources and communities.
- The RFP narrative structure required applicants to address issues relating not only about methods relating to biophysical research but also relating to collaboration, evaluation/adaptation and knowledge dissemination. Applicants were required to designate a "lead" for each of these four components of the proposal. In addition, it was not permissible for the biophysical lead to also be the collaboration lead.
- Eighteen preliminary proposals were submitted; seven went to the full proposal stage. At that stage, eight panelists read all seven proposals. While some panelists were strong in education and outreach, no social scientists nor collaboration or participatory process experts were used.
- Four 2-year projects were funded. The projects began in the Fall of 2009 and will be complete in next few months.

Methods

- See 2007 methods.
- In addition, I used direct observation of meetings between investigators & intended users to see firsthand how interactions were planned and implemented.

Results

- All four projects meeting expectations for linking science to decisions. There were disagreements (with one project as the exception) about whether projects had already influenced decisions.

- All four case studies were in agreement with the 2007 findings. In addition,

    - Funders should address scientists lack of ability to communicate effectively
    - Funders should address disincentives in science world (academia and government) regarding working on problems relevant to managers.

- Specifically regarding investigator-user interactions, funders should:

    - Augment meeting quantity (i.e., earlier in proposal development; more frequent) and quality (i.e., better prepared for challenges; clearer process).

Findings (see Best Practices List at End of Document)

2010 RFP Case Study Findings

Background (chapter pending)

- First year of the new NERRS Science Collaborative program, a five-year grant from NOAA's Estuarine Reserves Division. Goal is to link science with decisions at the NERRS (National Estuarine Research Reserve System).
- Research to address broad coastal management topics with an emphasis on involving intended users throughout.
- Methods and expertise for linking science to decisions put on par with science itself. Primer on collaborative research offered as part of RFP.
- Collaborative process experts used at preliminary proposal stage; panelists with general strengths in biophysical and outreach used at full proposal stage.
- Thirty four Letters of Intent submitted. All were given feedback and invited to submit full prop0sals. Twenty nine full proposals submitted; seven 3-year projects received awards. Projects began in fall of 2010.

Methods

- Directly observed meetings involving both investigators and intended users to gain firsthand knowledge of how interactions were planned and implemented.
- Used follow-up interviews after the meeting with two investigators and four intended users from each of four projects. Questions focused on the effectiveness of the meeting and ways to improve the meeting to better link science with decisions.

Results

- Formal Analysis Pending
- Have seen several projects meeting expectations and reporting significant benefits (e.g., increased credibility and relevance of research; increased enthusiasm of staff and stakeholders)
- Have also seen several projects struggle with the paradigm. Have seen interactions between scientists and users handled in sloppy manner as well as broader, more structural problems. (For example, a complete misunderstanding about the role of intended users in the project.)

Main Conclusions

- Pending
- Review process—and perhaps novelty of the research paradigm--resulted in some inconsistent quality to the project's start-up periods.

2010 Reviewer Interviews/Analysis

Background (for details, see Matso 2012, review process paper)

- Attempted to gain insight into different perspectives of the collaborative process by interviewing biophysical and collaborative process experts as well as more general panelists, all of whom participated in the review process for the first year of the NERRS Science Collaborative (see previous page).

Methods

- Read through all 116 peer reviews (29 proposals times four reviews each), looking for patterns in how the reviewers reacted to the proposals.
- In addition, conducted in-depth interviews with six applied science peer reviewers and six collaborative process peer reviewers. Also, reviewed survey data from the 10 full proposal panelists.
- Finally, asked all 87 peer reviewers to name funding programs that effectively combined research on natural and social systems.

Results

- Most agreed that more should be done to better link science with decisions.
- Interviews revealed an awareness discrepancy; collaborative process experts were aware of biophysical scientists but this was not true in the opposite direction. In addition, biophysical scientists didn't think collaborative process experts were necessary to link science to decisions.
- Natural scientists saw collaborative processes as being at tension with well-planned and credible science. Collaborative process experts, on the other hand, did not see credible natural science and credible collaborative processes as mutually exclusive.
- Many agreed that it would be beneficial for review processes to allow different sides to learn from each other.

Main Conclusions

- If linking science to decisions is a high priority, the review process must reflect a balanced approach, in contrast with the current approach, which tends to give short shrift to the collaborative process.

Preliminary Feedback on Latest RFPs (PhD chapter pending)

Background

- Using lessons learned from the first year of the NERRS Science Collaborative review process, staff made substantial changes to the review process for RFPs for Years 2 and 3, including:
    - Letter of Intent replaced by preliminary proposal stage.
    - No write-in reviewers used; instead, a dozen panelists used through each stage in order to build familiarity and continuity.
        - Panelists are interviewed before joining panel team to make sure that they understand and accept the intent of the RFP.
    - Each proposal assigned two reviewers of the science methods and two reviewers of the science linking methods.
    - Science panelists do not comment on science linking methods and the linking panelists do not comment on the science.
    - Increased outreach to applicants after each stage to increase opportunities for mutual learning.
- Changes made with expectation of a) reducing confusion and b) increasing effort allocated to collaborative process.

Methods

- Review various forms of formative evaluation data, including: online surveys, e-mails, and informal conversations.
- In addition, reviewed new proposals to discern patterns in expertise and rigor of collaborative methods as well as resource allocation.

Results

- Formal Results Pending
- Various comments (from panelists and applicants) indicated that the review process was unusually strong and certainly stronger than previous year.

Main Conclusions

- Pending

Objectives and Best Practice Alternatives

Definition of Terms

Fundamental Objective: The desired outcome (regardless of how it is achieved).
Means Objective: How we intend to get to the Fundamental Objective.
Best Practice: A specific action that funders can take to fulfill the means objective and make progress towards the fundamental objective.

Objectives & Best Practice Alternatives

Fundamental Objective: Improve the extent to which science links to decisions.

Means Objective 1: Ensure that the project has appropriate personnel, requisite methods and adequate resources (time, money) to best link science to decisions.

Best Practice 1: Funders request same level of rigor for science linking methods as for science generation methods; & funders are clear that both are a priority.

Best Practice 2: Funders ensure that they find and use experts in science linking (e.g., participatory process expert) to review relevant components of the proposal. Ideally, there should be as many science linking reviewers as science generation reviewers.

Best Practice 3: Funders should ensure that different kinds of reviewers have the opportunity to interact & learn from each other via the review process.

Means Objective 2: Ensure that research proposal reflects significant user input on a) what is highest priority research needed, b) the specific framing of the problem and c) the specific framing of the research approach to address the problem.

Best Practice 4: Funders should use RFP to define and raise the minimum extent to which investigators and users need to work together to frame the problem and agree on a research approach, either during proposal development or as part of the project itself (see Best Practice 5).

Best Practice 5: To accommodate project teams that have not had the time to collaboratively frame the problem and research approach, funders need to provide a mechanism to offer financial support for this activity. This can be done by either a) allowing needs assessment research within the main grant competition, or b) by offering a separate competition for this purpose.

Means Objective 3: Ensure that project structure reflects iterative learning and adaptability.

Best Practice 6: Require or encourage proposals to include at least two iteration loops (i.e., a pilot study) within the research project. Each iteration should include: needs assessment, research design, research implementation, and linking of results to decisions. Each iteration should be followed by an assessment of appropriate changes for future iterations.

<u>*Means Objective 4:*</u> *Ensure that distribution of power within the project team reflects the goal of linking science with decisions, not just generation of new science.*

Best Practice 7: Funders should use the RFP and the award contract—as well as a post-award verbal communication—to make clear that the person in charge of linking science with decisions has dual accountability: to the project team and to the funders. (This is similar but distinct from the Principal Investigator or Project Coordinator role, which is accountable to the funder for the general administration of the project.)

Or…

Best Practice 8: Funders use the RFP and the award contract to clarify that all projects will have a partnership management structure, with one component of the partnership represented by an investigator from the project team and the other component represented by a staff person from the funding organization.

<u>*Means Objective 5:*</u> *Ensure that project team is held accountable to the funders and the intent of the RFP.*

Best Practice 9: As part of the award process, funders should develop process-based metrics with the applicant team and tie continued funding to the team's ability to meet expectations.

<u>*Means Objective 6:*</u> *Increase commitment to working with applicants throughout the review process and project implementation to clarify this approach to better linking science with decisions.*

Best Practice 10: If funder does not have someone on staff with the time and significant experience linking science with decisions, the funder should contract with such a person to help oversee these aspects of the funding process throughout all stages of the competition and project implementation.

APPENDIX H

INSTITUTIONAL REVIEW BOARD APPROVAL

HUMAN SUBJECTS RESEARCH

From: "Simpson, Julie" <julie.simpson@unh.edu>
Date: December 5, 2011 7:11:36 AM EST
To: Kalle Matso <kmatso@wildcats.unh.edu>
Cc: "Becker, Mimi" <mlbecker@cisunix.unh.edu>
Subject: RE: Modification for IRB #4659

Kalle,

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) reviewed and approved the requested modification for this study. You are all set to implement your modification from the IRB's perspective. Your formal IRB modification approval letter will be emailed shortly.

**Please note the following:
- The IRB's new training requirement effective 9/1/11 ~ http://unh.edu/research/irb-training
- The IRB has posted a new application form (8/11) ~ http://unh.edu/research/forms/compliance-safety/human-subjects

For the IRB,

Julie F. Simpson, Ph.D.
Director, Research Integrity Services
University of New Hampshire
Service Building, Room 103
51 College Road
Durham, NH 03824-3585
Phone: 603/862-2003 * Fax: 603/862-3564
Email: julie.simpson@unh.edu

From: Kalle Matso [mailto:kmatso@wildcats.unh.edu]
Sent: Friday, December 02, 2011 5:40 PM
To: Simpson, Julie
Cc: Becker, Mimi
Subject: Re: Modification for IRB #4659

Thank you very much, Julie.

I have made the suggested change and attached the revised document.

Take care,

Kalle

On Dec 2, 2011, at 11:43 AM, Simpson, Julie wrote:

Kalle,

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) reviewed your modification request and requested the following:

1. The researcher needs to address the following in the ***consent information*** *and submit the revised document to the IRB for review:*
a. *As the questions will be asked in a focus group setting, the researcher needs to add to the section on confidentiality a statement to the effect that although the researcher plans to maintain confidentiality of responses, other focus group participants may repeat responses outside the focus group setting.*

The IRB will continue its review of your request upon receipt of the information requested above. **Formal written approval will not be issued until the IRB reviews and approves your response. You may not implement the proposed modification until formal written approval is issued by the IRB.** Please respond to the IRB within sixty days of this notification. If the IRB does not receive a response within sixty days, your request will be withdrawn from consideration.

With regard to requests for changes to documents, please submit all revised documents to the IRB for review. Responses to the IRB should be sent to me and may be submitted via email, fax, campus mail or U.S. mail, depending upon the nature of the requested information.

If you have questions or concerns about these contingencies, please contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study.

For the IRB,

Julie F. Simpson, Ph.D.
Director, Research Integrity Services
University of New Hampshire
Service Building, Room 103
51 College Road
Durham, NH 03824-3585
Phone: 603/862-2003 * Fax: 603/862-3564
Email: julie.simpson@unh.edu

From: Kalle Matso [mailto:kmatso@wildcats.unh.edu]
Sent: Monday, November 21, 2011 4:18 PM
To: Simpson, Julie
Cc: Becker, Mimi
Subject: Re: Modification for IRB #4659

Hi Julie,

Hope this e-mail finds you well.

I wanted to submit an additional modification for my PhD study. It's very straight forward...just involves the addition of a focus group. I've attached below the modification form and two supporting documents.

Please let me know if there's anything else I can do to keep these going.

Thanks,

Kalle

On Jul 29, 2010, at 8:14 AM, Simpson, Julie wrote:

Kalle,

IRB #: 4659
Study: Supporting More Useful Science: New Methods for Implementing and Assessing Applied Coastal Research

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) reviewed and approved the requested modification for this study. You are all set to implement your modification from the IRB's perspective. Your formal IRB modification approval letter will be emailed shortly.

For the IRB,

Julie F. Simpson, Ph.D.
Manager, Research Integrity Services
Office of Sponsored Research
University of New Hampshire
51 College Road, Room 103
Durham, NH 03824-3585
Phone: 603/862-2003 * Fax: 603/862-3564
Email: julie.simpson@unh.edu